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Educational Product

Educators | Grades 3–5

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The NASA Sci Files™

The Case of the Physical Fitness Challenge

An Educator Guide with Activities in Mathematics, Science, and Technology

NASA's CENTER FOR DISTANCE LEARNING

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The Case of the Physical Fitness Challenge educator guide is available in electronic format. A PDF version of the educator guide for NASA SCI Files™ can be found at the NASA SCI Files™ web site:
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The NASA SCI Files™

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The NASA
Sci
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Program Overview

In *The Case of the Physical Fitness Challenge*, the tree house detectives are excited about their school's participation in the upcoming President's Challenge. All the detectives are hoping to be physically fit in time for the competition so they can win the Presidential Physical Fitness Award. Therefore, when RJ has difficulty keeping up with the fitness routine, the detectives go into action to help him get back on track. They do some research and discover that researchers at NASA Johnson Space Center in Houston, Texas are also interested in good health and nutrition. Tony heads over to speak with Mr. William Amonette, an Astronaut Strength and Conditioning Specialist. Mr. Amonette explains the importance of physical activity and how astronauts must exercise before, during, and after space flight. While talking with Mr. Amonette, Tony learns that physical activity is not possible without muscles, so he goes to see Dr. Don Hagan, who explains what muscles are and the various types of muscles in the body. After reading Tony's reports, the detectives are not sure what to do next. They decide to stop by to talk with Dr. D. As Dr. D works on his car, he explains how the body is similar to a car because it has many systems. Thinking of systems, the tree house detectives decide that they might need to learn a little more about the skeletal system.

Back at the tree house, RJ and Kali dial up Dr. Scott Smith at NASA Johnson Space Center, who explains how muscles and bones work together in the musculoskeletal system. He also makes clear the importance of nutrition and physical activity for the growth of healthy bones and explains why astronauts must continue to exercise in space to maintain bone health. Deciding that bones are an important part of being physically fit, RJ and Bianca check out the NASA SCI Files™ Kids' Club to learn more, and they dial up a classroom in Dundee, Scotland. Mr. David Shand's class at the Harris Academy has just finished conducting an experiment on how calcium loss affects bones. The detectives begin to realize that nutrition plays an important role in being physically fit and staying healthy. They decide to contact a doctor to learn more about nutrition. Bianca is on her way to Washington, D.C. and is able to get an appointment with Vice Admiral Richard H. Carmona, M.D., M.P.H., FACS, the U.S. Surgeon General! Vice Admiral Carmona explains what nutrients are and why they are important to good health. Meanwhile, back at Dr. D's lab, Dr. D explains that a calorie is a unit of measure that tells us the amount of energy stored in food and how our bodies combine oxygen with nutrients to produce energy. The detectives are sure they are on the right track but realize that there is much more to learn.

While jogging at Sandy Bottom Nature Park in Hampton, Virginia, the detectives remember that the U.S. Surgeon General, Vice Admiral Carmona, had suggested that they need to learn more about the new food guide pyramid. They email Tony, who heads over to Texas A&M University in College Station, Texas to visit Dr. Joanne Lupton, Regents Professor and Program Leader for the National Space Biomedical Research Institute (NSBRI). Dr. Lupton also worked with the Food and Drug Administration (FDA) to help create new dietary guidelines, and she explains the new food guide pyramid categories and how to determine the correct number of portions in each group for an individual. Dr. Lupton recommends that they speak with Dr. Ted Mitchell of the Cooper Clinic in Dallas, Texas and a member of the Science Board for the President's Council of Physical Fitness and Sports. Bianca and Blake dial up Dr. Mitchell to learn about a person's basal metabolic rate (BMR) and why it is important to calculate BMR. Bianca and Blake also get some help from a NASA SCI Files™ Kids' Club member, Callum Mackie, who visits Ms. Gill Poulter at the Discovery Point Antarctic Museum in Dundee, Scotland. Ms. Poulter explains the importance of nutrition in exploration and tells them that when the RRS *Discovery* made the first exploration expedition to Antarctica, nutrition was a concern but little was known about it.

As the tree house detectives start to pull all the pieces together, they are beginning to realize that being physically fit involves more than they thought and that they need to make lifestyle changes. For some advice on how to be physically active for life, they visit Mr. Lynn Swann, former NFL football player and ABC Commentator, who also just happens to have been the Chairman for the President's Council for Physical Fitness and Sports. Mr. Swann helps the detectives learn that physical activity should be fun and something you enjoy doing so that you continue to be active. Meanwhile, the kids back in Scotland have been doing some more research of their own, and they head to the RRS *Discovery* to meet astronaut Alvin Drew to learn what NASA is doing to help keep astronauts healthy during long-duration space travel. Finally, the detectives are ready to put all the pieces together to help RJ get in shape, and they meet Dr. D for a wrap-up explaining that a healthy lifestyle includes many things, but especially proper nutrition and daily physical activity.

National Science Standards (Grades K-4)

STANDARD	SEGMENT			
Unifying Concepts and Processes	**1**	**2**	**3**	**4**
Systems, orders, and organization	•	•	•	•
Evidence, models, and explanations	•	•	•	•
Change, constancy, and measurement	•	•	•	•
Form and function	•	•	•	•
Science and Inquiry (A)				
Abilities necessary to do scientific inquiry	•	•	•	•
Understandings about scientific inquiry	•	•	•	•
Physical Science (B)				
Light, heat, electricity, and magnetism	•	•	•	•
Science and Technology (E)				
Abilities of technological design	•	•	•	•
Understandings about science and technology	•	•	•	•
Science in Personal and Social Perspective (F)				
Personal health	•	•	•	•
Types of resources	•	•	•	•
Changes in environments	•	•	•	•
Science and technology in local challenges	•	•	•	•
History and Nature of Science (G)				
Science as a human endeavor	•	•	•	•

National Science Standards (Grades 5-8)

STANDARD	SEGMENT			
Unifying Concepts and Processes	**1**	**2**	**3**	**4**
Systems, order, and organization	•	•	•	•
Evidence, models, and explanations	•	•	•	•
Change, constancy, and measurement	•	•	•	•
Form and function	•	•	•	•
Science as Inquiry (A)				
Abilities necessary to do scientific inquiry	•	•	•	•
Understandings about scientific inquiry	•	•	•	•
Physical Science (B)				
Transfer of energy		•		
Life Science (C)				
Structure and function in living systems	•	•	•	•
Science and Technology (E)				
Abilities of technological design	•	•	•	•
Understanding about science and technology	•	•	•	•
Science in Personal and Social Perspectives (F)				
Personal Health	•	•	•	•
Risks and benefits	•	•	•	•
Science and technology in society	•	•	•	•
History and Nature of Science (G)				
Science as a human endeavor	•	•	•	•
Nature of science	•	•	•	•
History of science			•	

National Mathematics Standards for Grades 3-5

STANDARD	SEGMENT 1	2	3	4
Number and Operations				
Understand meanings of operations and how they relate to one another.		•	•	
Compute fluently and make reasonable estimates.		•	•	
Algebra				
Represent and analyze mathematical situations and structures using algebraic symbols.			•	
Use mathematical models to represent and understand quantitative relationships.			•	
Analyze change in various contexts.			•	
Measurement				
Understand measurable attributes of objects and the units, systems, and processes of measurement.		•		
Apply appropriate techniques, tools, and formulas to determine measurements.		•		
Data Analysis and Probability				
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.		•		
Select and use appropriate statistical methods to analyze data.		•		
Develop and evaluate inferences and predictions that are based on data.		•		
Understand and apply basic concepts of probability.		•		
Problem Solving				
Solve problems that arise in mathematics and in other contexts.	•	•	•	•
Apply and adapt a variety of appropriate strategies to solve problems.	•	•	•	•
Monitor and reflect on the process of mathematical problem solving.	•	•	•	•
Communication				
Communicate mathematical thinking coherently and clearly to peers, teachers, and others.		•	•	

National Educational Technology Standards Performance Indicators for Technology-Literate Students Grades 3-5

STANDARD	SEGMENT			
Basic Operations and Concepts	**1**	**2**	**3**	**4**
Use keyboards and other common input and output devices efficiently and effectively.	•	•	•	•
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	•	•	•	•
Social, Ethical, and Human Issues				
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	•	•	•	•
Discuss basic issues related to responsible use of technology and information and describe personal consequences of inappropriate use.	•	•	•	•
Technology Productivity Tools				
Use general-purpose productivity tools and peripherals to support personal productivity, remediate skill deficits, and facilitate learning throughout the curriculum.	•	•	•	•
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	•	•	•	•
Technology Communication Tools				
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	•	•	•	•
Use telecommunication efficiently and effectively to access remote information, communicate with others in support of direct and independent learning, and pursue personal interests.	•	•	•	•
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	•	•	•	•
Technology Research Tools				
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	•	•	•	•
Use technology resources for problem solving, self-directed learning, and extended learning activities.	•	•	•	•
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	•	•	•	•

National Educational Technology Standards Performance Indicators for Technology-Literate Students Grades 3-5

(concluded)

STANDARD	SEGMENT			
Technology Problem-Solving and Decision-Making Tools	**1**	**2**	**3**	**4**
Use technology resources for problem solving, self-directed learning, and extended learning activities.	•	•	•	•
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	•	•	•	•

International Technology Education Association Standards for Technological Literacy Grades 3-5

STANDARD	SEGMENT			
The Nature of Technology	**1**	**2**	**3**	**4**
Standard 1: Students will develop an understanding of the characteristics and scope of technology.	•	•	•	•
Standard 2: Students will develop an understanding of the core concepts of technology.	•	•	•	•
Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.	•	•	•	•
Technology and Society				
Standard 6: Students will develop an understanding of the role of society in the development and use of technology.	•	•	•	•
Standard 7: Students will develop an understanding of the influence of technology on history.	•	•	•	•
The Designed World				
Standard 14: Students will develop an understanding of and be able to select and use medical technologies.	•	•	•	•

National Geography Standards

STANDARD	SEGMENT			
The geographically informed person knows and understands:	**1**	**2**	**3**	**4**
Places and Regions				
The physical and human characteristics of places			•	
That people create regions to interpret Earth's complexity			•	
How culture and experience influence people's perceptions of places and regions			•	
Environment and Society				
How human actions modify the physical environment			•	
How physical systems affect human systems			•	
The changes that occur in the meaning, use, distribution, and importance of resources			•	

National Health Education Standards For Grades K–4

STANDARD	SEGMENT			
Comprehend concepts related to health promotion promotion and disease prevention.	**1**	**2**	**3**	**4**
Describe relationships between personal health behaviors and individual well-being.	•	•	•	•
Identify indicators of mental, emotional, social, and physical health during childhood.	•	•	•	•
Describe the basic structure and functions of the human body systems.	•	•		
Describe how physical, social, and emotional environments influence personal health.	•	•	•	•
Demonstrate the ability to access valid health information and health-promoting products and services.				
Identify characteristics of valid health information and health-promoting products and services.	•	•	•	•
Demonstrate the ability to locate resources from home, school, and community that provide valid health information.	•	•	•	•
Demonstrate the ability to locate school and community health helpers.	•	•	•	•
Demonstrate the ability to practice health-enhancing behaviors and reduce health risks.				
Identify responsible health behaviors.	•	•	•	•
Identify personal health needs.	•	•	•	•

National Health Education Standards For Grades K–4

STANDARD	SEGMENT			
Demonstrate the ability to practice health-enhancing behaviors and reduce health risks.	1	2	3	4
Compare behaviors that are safe to those that are risky or harmful.	•	•	•	•
Demonstrate strategies to improve or maintain personal health.	•	•	•	•
Develop injury prevention and management strategies for personal health.				•
Apply skills to manage stress.	•			•
Analyze the influence of culture, media, technology, and other factors on health.				
Describe ways technology can influence personal health.	•	•	•	•
Demonstrate the ability to use goal-setting and decision-making skills to enhance health.				
Demonstrate the ability to apply a decision-making process to health issues and problems.	•	•	•	•
Explain when to ask for assistance in making health-related decisions and setting health goals.	•	•	•	•
Predict outcomes of positive health decisions.	•	•	•	•
Set a personal health goal and track progress toward its achievement.	•	•	•	•
Demonstrate the ability to advocate for personal, family, and community health.				
Describe a variety of methods to convey accurate health information and ideas.	•	•	•	•
Express information and opinions about health issues.	•	•	•	•
Identify community agencies that advocate for healthy individuals, families, and communities.	•	•	•	•
Demonstrate the ability to influence and support others in making positive health choices.	•	•	•	•

The NASA SCI Files™

The Case of the Physical Fitness Challenge

Segment 1

In *The Case of the Physical Fitness Challenge*, the tree house detectives are excited about their school's participation in the upcoming President's Challenge. All the detectives are hoping to be physically fit in time for the competition so they can win the Presidential Physical Fitness Award. Therefore, when RJ has difficulty keeping up with the fitness routine, they go into action to help him get back on track. The detectives do some research and discover that researchers at NASA Johnson Space Center in Houston, Texas are also interested in good health and nutrition. Tony heads over to speak with Mr. William Amonette, an Astronaut Strength and Conditioning Specialist. Mr. Amonette explains the importance of physical activity and tells Tony how astronauts must exercise before, during, and after space flight. While talking with Mr. Amonette, Tony learns that physical activity is not possible without muscles, so he goes to see Dr. Don Hagan, who explains what muscles are and the various types of muscles in the body. After reading Tony's reports, the detectives are not sure what to do next. They decide to stop by to talk with Dr. D. As Dr. D works on his car, he explains how the body is similar to a car because it has many systems. Thinking of systems, the tree house detectives decide that they might need to learn a little more about the skeletal system.

Objectives

Students will

- determine the importance of physical activity to a healthy lifestyle.
- discover how the heart pumps blood throughout the body.
- locate their pulse points and calculate their heart rates.
- prove that the more active a person is, the more the heart works to supply blood to the body.
- confirm that muscle strength and endurance increase over time with good stress.
- examine the structure of skeletal muscles.
- construct an arm model.
- discover the relationship between muscles and bones.
- learn about the different kinds of body joints and how they move.
- demonstrate the need for muscle groups.
- acquire knowledge about the body and its parts.
- understand that body parts make up body systems and that each part has a specific function.

Vocabulary

aerobic activities – activities designed to increase the amount of oxygen in the blood

cardiac muscles – a special kind of involuntary muscle found in the heart (which works without a person's thinking about it)

exercise – any physical activity that raises your heart rate or makes you work hard to lift or pull an object, including your own body

joint – a place where two or more bones meet

muscles – soft, but strong tissue made of long fibers that contract or become shorter to move bones; muscles can only pull in one direction so they must work in pairs

resistive exercise – an activity that strengthens bone and muscle by generating force against resistance

skeletal muscles – a group of voluntary muscles (muscles that you can control), which are attached to bones or other muscles to help you move

smooth muscles – a group of involuntary muscles (muscles that work without conscious thought), which make up most of the body organs such as the stomach, insides of blood vessels, intestines, and others

stress – emotional tension or physical force; physical stress is created when bones and muscles work against a force

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Before viewing Segment 1 of *The Case of the Physical Fitness Challenge*, read the program overview to the students. List and discuss questions and preconceptions that students may have about physical fitness and nutrition.
2. Record a list of issues and questions that the students want answered in the program. Determine why it is important to define the problem before beginning. From this list, guide students to create a class or team list of three issues and four questions that will help them better understand the problem. To locate the following tools on the NASA SCI Files™ web site, select **Educators** from the menu bar, click on **Tools**, and then select **Instructional Tools**. You will find them listed under the **Problem-Based Learning** tab.

   Problem Board—Printable form to create student or class K-W-L chart

   Guiding Questions for Problem Solving—Questions for students to use while conducting research

   Problem Log and Rubric—Students' printable log with the stages of the problem-solving process

   Brainstorming Map—Graphic representation of key concepts and their relationships

   The Scientific Method and Flowchart—Chart that describes the scientific method process
3. **Focus Questions**—These questions at the beginning of each segment help students focus on a reason for viewing. You can print them ahead of time from the **Educators** area. Students should copy these questions into their science journals prior to viewing the program. Encourage students to take notes while viewing the program to help them answer the questions. An icon will appear when the answer is near.

Video Component

4. **"What's Up?" Questions**—These questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. You can print them by selecting **Educators** on the web site in the **Activities/ Worksheet** section under **Worksheets** for the current episode.

Careers

astronaut
Astronaut Strength and Conditioning Specialist
athlete
athletic trainer
coach
exercise specialist
physical education teacher

View Segment 1 of the Video

For optimal educational benefit, view *The Case of the Physical Fitness Challenge* in 15-minute segments and not in its entirety. If you are watching a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" Questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Students should work in groups or as a class to discuss and list what they know about physical fitness and nutrition. Have the students conduct research about how astronauts stay in shape while in space, about the types of muscles in the body and how they are used, and about the President's Physical Fitness Challenge. Brainstorm for ideas about how they can stay healthy and be physically fit. As a class, reach a consensus on what additional information is needed. Have the students conduct independent research or provide them with the information needed.
4. Have the students complete **Action Plans**, which can be printed from the **Educators** area or the tree house **Problem Board** area in the **Problem-Solving Tools** section of the web site for the current online investigation. Students should then conduct independent or group research by using books and internet sites noted in the **Research Rack** section of the **Problem Board** in the **Tree House**. Educators can also search for resources by topic, episode, and media type under the **Educators** main menu option **Resources**.
5. Choose activities from the **Educator Guide** and web site to reinforce concepts discussed in the segment. The variety of activities is designed to enrich and enhance your curriculum. Activities may also be used to help students "solve" the problem along with the tree house detectives.
6. For related activities from previous programs, download the appropriate **Educator Guide**. On the NASA SCI Files™ home page, select the fence post that says "**Guides**." Click on the **2002–2003 Season** tab and then click on *The Case of the Biological Biosphere©*. In the green box, click on **Download the Educator Guide**.
   a. In the **Educator Guide** you will find
      a. Segment 2 – *Give Me Some Skin,* page 31
      b. Segment 2 – *Just Breathe*, page 32
      c. Segment 4 – *Getting to the Heart of the Matter*, page 56

   To locate additional activities and worksheets on the web, click on **Activities/Worksheets** in the tool bar located at the top of the window. Scroll to the **2002–2003 Season** and click on, *The Case of the Biological Biosphere©*. In the **Activities/Worksheet** section, you will find
   a. *Body System Booklet*
   b. *In the Beat of a Heart*
7. Have the students work individually, in pairs, or in small groups on the problem-based learning (PBL) activity on the NASA SCI Files™ web site. To locate the PBL activity, click on **Tree House** and then the **Problem Board**. Choose the **2005–2006 Season** and click on *The Case of the Sedentary Students.*
   - To begin the PBL activity, read the scenario *(Here's the Situation)* to the students.
   - Read and discuss the various roles involved in the investigation.
   - Print the criteria for the investigation and distribute.
   - Have students begin their investigation by using the **Research Rack** and the **Problem-Solving Tools** located on the bottom menu bar for the PBL activity. The **Research Rack** is also located in the **Tree House**.
8. Having students reflect in their journals what they have learned from this segment and from their own experimentation and research is one way to assess student progress. In the beginning, students may have difficulty reflecting. To help them, ask specific questions that are related to the concepts.

9. Have students complete a **Reflection Journal**, which can be found in the **Problem-Solving Tools** section of the online PBL investigation or in the **Instructional Tools** section under **Educators**.
10. The NASA SCI Files™ web site provides educators with general and specific evaluation tools for cooperative learning, scientific investigation, and the problem-solving process.

Resources *(additional resources located on web site)*

Books

Bolam, Emily: *Murphy Meets the Treadmill*. Houghton Mifflin Company, 2001, ISBN: 0618113576.

Christopher, Catherine: *Run for It*. Little, Brown Children's Books, 2002, ISBN: 0316349143.

Columbo, Luann: *Uncover the Human Body*. Silver Dolphin Books, 2003, ISBN: 1571457895.

Feeney, Kathy: *Get Moving: Tips on Exercise.* Capstone Press, 2001, ISBN: 0736809732.

Fraser, Kate: *Fitness and Health.* Usborne Books, 1999, ISBN: 0881102342.

Kalman, Bobbie: *Active Kids.* Crabtree Publishing Company, 2003, ISBN: 0778712753.

National Association for Sport and Physical Fitness: *Moving into the Future: National Standards for Physical Education.* McGraw-Hill Companies, 2004, ISBN: 0883149095.

Simon, Seymour: *Muscles: Our Muscular System*. William Morrow and Company, 1998, ISBN: 0688146422.

Wiese, Jim: *Head to Toe Science: Over 40 Eye-Popping, Spine-Tingling, Heart-Pounding Activities that Teach Kids about the Human Body*. Wiley, 2000, ISBN: 0471332038

Wyatt, Valerie: *Earthlings Inside and Out: A Space Alien Studies the Human Body*. Kids Can Press, 1999, ISBN: 1550745131.

Video

NASA Center for Distance Learning: *NASA CONNECT: Better Health from Space to Earth* (2003)
http://connect.larc.nasa.gov/programs/2003-2004/better_health/index.html
Grades 6–8

NASA Center for Distance Learning: *NASA CONNECT: Good Stress: Building Better Muscles and Bones* (2004)
http://connect.larc.nasa.gov/programs/2004-2005/good_stress/index.html
Grades 6–8

Discovery Communications: *Why Exercise?* (2002)
Grades 3–5

Discovery School: *Body Systems* (2004)
Grades 3–6

Discovery School: *Bones and Muscles* (2004)
Grades 3–6

Disney: *Bill Nye, the Science Guy: Bones and Muscles* (1996)
Grades 3–6

Disney: *Bill Nye, the Science Guy: Heart* (1995)
Grades 3–6

Schlessinger Media: *All about Bones and Muscles* (2001)
Grades K–4

Scholastic: *Magic School Bus: The Human Body* (2005)
Grades K–5

Web Sites

NASA Johnson Space Center
From the early Gemini, Apollo, and Skylab projects to today's International Space Station and Space Shuttle Programs, NASA Johnson Space Center, in Houston, Texas, continues to lead NASA's efforts in human space exploration. *http://www.nasa.gov/centers/johnson/home/index.html*

NASA CONNECT™
Visit the NASA CONNECT™ web site. It's a great place to learn more about how to stay fit and healthy.
http://connect.larc.nasa.gov/index.html

National Space Biomedical Research Institute
Learn more about the body and how to keep it healthy on this fact-filled web site. Be sure to click on the Educational Materials link to access the teacher guides, *Muscles and Bones* and *Food and Fitness*.
http://www.nsbri.org/Education/index.html

All Systems Go
Build a virtual human being to learn about the different body systems on this fun, interactive web site operated by Science Net Links.
http://www.sciencenetlinks.com/interactives/systems.html

ScienceBob.com
Explore this web site to learn all about the body and its systems.
http://www.sciencebob.com/

Activities and Worksheets

Let's Get Physical

Segment 1

Purpose

To determine the importance of physical activity for a healthy lifestyle

Materials

Physical Activity worksheet (page 20)
pen or pencil
markers
poster board

Background

Physical activity is an important part of a healthy lifestyle. Many people today do not get enough physical activity in their daily lives. People spend much of their day being inactive, either sitting at their jobs or at school. Cars or buses have replaced walking and bicycle riding as the common types of transportation used to get from one place to another. This inactivity can lead to serious health risks. The President's Council on Physical Fitness recommends approximately 60 minutes of exercise per day for children under 18 years. Studies show that daily physical activity can help lower the risk of heart disease and obesity. People who are physically active tend to have more energy and a better body image. They are better able to deal with bad stress and overall are more relaxed. Physical activity can help tone muscles, burn extra calories to help lose weight, and can help control your appetite. Physical activity is also essential to healthy bones. Even light to moderate physical activity is better than no physical activity at all. The benefits of physical activity are great and can help you enjoy life more fully. Finding physical activities that are challenging but fun will help develop lifelong fitness habits.

Procedure

1. Use the Physical Activity worksheet to survey people about their physical activities. Ask people that you know what physical activity they participate in most often and why and how many minutes a day they are physically active.
2. In the chart on the worksheet, record their responses.
3. To graph your results, first determine the categories of the various physical activities given. Categories might include sports, leisure activities (walking, running, shopping), no activity, and so on.
4. Create two graphs. **Example:** The first graph might be a pie graph that shows the types of physical activities in which people participate. Be sure to include those inactive people who responded "no" to physical activity. The second graph might be a bar graph to show the reasons why people are physically active.
5. Calculate the average number of minutes of physical activity performed by the people surveyed.
6. Share your results with your class or partner.
7. Create a class graph of all results and calculate the average number of minutes of physical activity for all people surveyed by the class. Find the mean, median, and mode.
8. After looking at the results, discuss the overall physical fitness level of those surveyed. Are most people who were surveyed getting enough physical activity?
9. Conduct research to learn more about the benefits of physical fitness.
10. Based on your survey and what you have learned about the importance of physical activity, create a poster, PowerPoint presentation, or a 30-second public service announcement to explain the importance of physical activity to a healthy lifestyle.

Discussion

1. Based on your survey results, how much value do you think people in your community place on physical fitness?
2. What was the most common reason people you interviewed chose to become physically active?
3. What are some of the benefits of physical activity?
4. How do you feel about physical activity?
5. What are some popular activities students can do to improve physical fitness?

Let's Get Physical

Extensions

1. Monitor your own physical activity for a week. Keep a log of all the activities you do. To track how you feel before and after physical activity, create a scale. Use this scale each day to indicate your overall feelings (energy level, attitude, and so on). Be sure to record your scores. After a week, take a close look at your activities. Are you physically active on a daily basis? Do you need more physical activity? Brainstorm for ways to add more physical activity to your life. The following week, try adding some of your ideas into your normal routine. Continue logging all your activities for the week. After a week, did you notice a difference in the way you felt? What are you going to do to make sure that you are more physically active on a daily basis?
2. Contact the President's Council on Physical Fitness and Sports, the American Heart Association, a local physical fitness center, or your family doctor to learn more about physical fitness and its importance. Create a report on your findings.
3. Learn about a pedometer and explain how to use physical activity. Use this instrument to monitor physical activity.

PHYSICAL ACTIVITY WORKSHEET

Are you physically active? Yes or No	If yes, what physical activity do you do most often?	If yes, why are you physically active? (To look good; to be healthy; to feel good, to firm muscles, to lose weight, for enjoyment.)	How many minutes a day are you physically active?	How many times a week are you physically active?

Pumping Up the Stress

Segment 1

Purpose

To discover how the heart pumps blood throughout the body

To prove that the more active a person is, the more the heart works to supply blood to the body

To locate your pulse points and calculate your heart rate

Materials

bicycle tire pump
1 m of rubber tubing
2 funnels
masking tape
timer (stopwatch or clock with second hand)
Heart Stress Test chart (p. 23)
pen or pencil
colored pencils
science journal

Background

The heart is a muscle in your body. It is located slightly to the left of the middle of your chest and is about the size of your fist. The heart's job is to send blood throughout your body. Blood gives your body the oxygen and nutrients it needs and carries away waste products. The heart is like a double pump. The right side of the heart receives the oxygen depleted blood from the body and pumps it to the lungs. The left side of the heart receives the oxygen rich blood from the lungs and pumps it to the body. It takes your heart less than 60 seconds to pump blood to every cell in your body. As your heart pumps, valves inside your heart open and close. This opening and closing makes a distinct sound known as your "heartbeat." You can hear the heartbeat by using a stethoscope, a medical tool used to hear sounds within the body. Your heart will beat slower when your body is at rest and faster when it is active. This increase in heartbeat occurs because the more active you are, the more oxygen rich blood your body needs. Your heart must pump faster to accommodate the increase in need. Your heart rate is the number of times the heart beats per minute.

Aerobic activities are designed to make your heart beat faster and increase the amount of oxygen in the blood. According to the Center for Disease Control (CDC), aerobic activities improve the function of the heart, may help lower blood pressure, help control weight, and increase a person's overall feeling of well-being.

Procedure

1. To demonstrate the pumping action of the heart, pull the handle up on the bicycle tire pump and push it down. Repeat several times and feel the air that is pumped through the hose.
2. Think about how this pump is similar to a heart. Instead of pumping air, the heart pushes blood throughout the body. In your science journal, describe how you think the heart works.
3. To listen to the sound your heart makes as it works, make a simple stethoscope.
   a. Attach a funnel to one end of the rubber tubing with masking tape.
   b. Repeat and attach the second funnel to the other end of the rubber tubing. See diagram 1.
4. Sit still for about 3 minutes in a quiet location.
5. Tightly hold one funnel up to your ear.
6. Hold the other funnel up to your heart or a partner's heart (remember the heart is located slightly to the left of the middle of your chest).
7. While continuing to sit, listen carefully until you hear the sound of the heart beating. See diagram 2.
8. Using the timer, count the number of heartbeats in 10 seconds. Record the number in your science journal.
9. To find the number of beats per minute, multiply the number of beats in 10 seconds by 6. Record the answer in the Heart Stress Test chart for Trial 1. Note: Another way for older students to find a pulse is to locate the pulse in the inner wrist, neck, or temple and to place two fingers over the pulse. As they feel the pulse beat, they can count the number of beats for 15 seconds and multiply by four.
10. Repeat steps 5–9 for two more trials. See diagram 3.
11. Find the average of the three numbers and record it in the chart. This number is your average sitting heart rate.

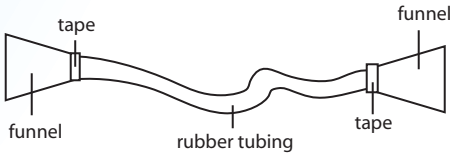


Diagram 1

Diagram 2

Pumping Up the Stress

12. Predict what will happen to your heart rate after you begin physical activity and as activity is increased. Record your predictions in the space provided at the bottom of the chart.
13. To find your standing heart rate, stand up and wait about a minute. Repeat steps 5–11 while standing.
14. Use steps 5-11 as a guide to determine your heart rate while performing the following activities.

    a. In an open area away from objects and people, swing your arms back and forth for 20 seconds.

    b. Wait 2 minutes to allow your heart rate to return to normal and then walk briskly around the room for 30 seconds.

    c. Wait 2 minutes and then hop 25 hops around the room.

    d. Wait 2 minutes and then run in place for 30 seconds.
15. Make a graph to show how your heart rate changed during each of the activities. Be sure to include your sitting heart rate on the graph.
16. Compare your data to that of other students in your class. How do you compare?
17. Using each student's data, calculate the class's average heart rate for each activity and graph the results. Discuss results, looking for patterns.
18. Create a new graph to compare the heart rates of boys versus girls.

    a. Choose two different colored pencils.

    b. Calculate the average heart rate for the girls for each activity and graph the results in one color.

    c. Calculate the average heart rate for the boys for each activity and graph the results on the same graph but using a different color.
19. Compare the graphs of the average heart rate for the various activities between the girls and the boys in your class and discuss any similarities or differences between the two sets of data.

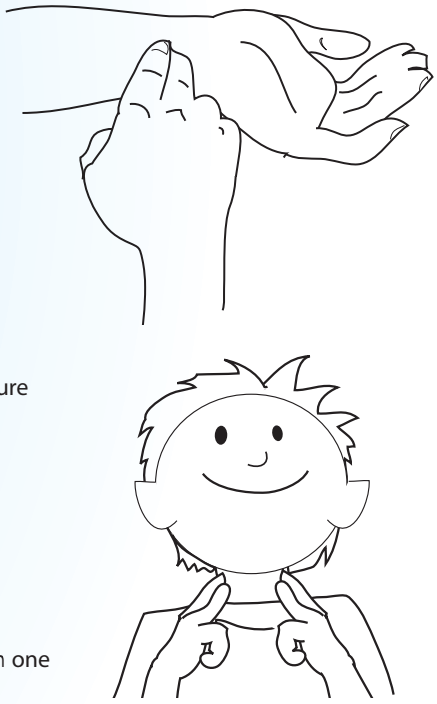


Diagram 3

Discussion

1. When was your heart rate the slowest? When was it the fastest?
2. Did your heart rate increase with physical activity? Why or why not?
3. How do you think an extended period of physical activity would affect your heart rate?
4. Was there a difference between the heart rate of the girls versus the heart rate of the boys? Why or why not?
5. Why is aerobic activity important?

Extension

1. Extend the various activities for a longer period of time. Record the new heart rates and the length of the activity.
2. Research to learn more about the heart and its parts. Make a diagram of the inside of the heart.
3. Build a 3-D model of the heart. Use the Internet and the library as resources to help make your model.
4. Have a teacher or parent contact a grocery store meat department or meat packing plant to obtain a cow or pig heart for dissection.

Pumping Up the Stress

Segment 1

Heart Stress Test Chart

Activity	**Trial 1 Beats per Minute**	**Trial 2 Beats per Minute**	**Trial 3 Beats per Minute**	**Average * Beats per Minute**
Sitting				
Standing				
Swinging Arms				
Fast Walk				
Hopping				
Running				

* Note: To calculate the average number of beats per minute, add the three numbers for each activity and divide that number by three.

What will happen when activity is increased?

Prediction: _____

_____

_____

Stress This*

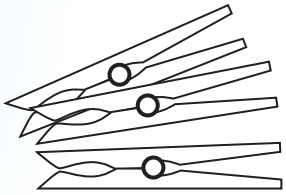
Segment 1

Purpose

To confirm that muscle strength and endurance increase over time with good stress

Materials

spring-hinge clothespin
Stress This Table (p. 25)
pencil
timer (stopwatch or clock with second hand)
science journal

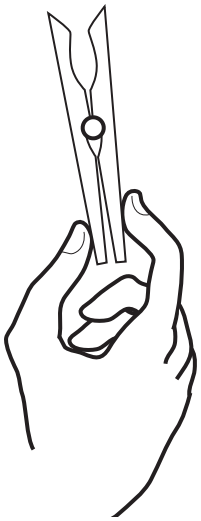


Background

When you think of stress, you usually think of something bad that is happening. Too much bad stress can harm your health, but not all stress is bad. Actually, stress is an important part of a healthy life. Walking, carrying heavy items, and climbing are all physical stresses. Reading, playing a board game, and doing your homework are all mental stresses. Our bodies require some physical and mental stress to be healthy and to grow. Physical stress happens when bones and muscles work against a force. Stress from physical activity is necessary for healthy, strong muscles. Physical stress is extremely important during the growing years, from birth until about age 25. Even after you stop growing, bones need physical stress to maintain thickness and strength. Muscles rebuild and grow as a result of physical stress. Stress can change muscle strength or muscle endurance (the ability to perform an activity for a long time without becoming tired). Muscle endurance is built through repetition. The more frequently muscles perform the same task, the better they become at completing the task and the longer they can perform the task before becoming tired or weak. High-intensity, short duration exercises (or stresses), such as weight lifting, cause muscles to increase in strength. Low-intensity, long-duration activities, such as running and swimming, cause muscles to increase in stamina.

Being fit and healthy means performing physical activities that will improve endurance, flexibility, and strength. When beginning a physical activity, it is important to do the right amount. Doing too much too soon might cause injury. Physical activities should be challenging, but not painful or exhausting.

Procedure



1. Write the date in the first row in the Stress This Table.
2. Predict the number of times you will be able to click the clothespin between your thumb and index finger in your dominant hand for a 1-minute period. (Your dominant hand is usually the hand you use to write.)
3. Record your prediction for trial 1 in the table.
4. Hold the clothespin in your dominant hand between your thumb and index finger.
5. Have your partner time 1 minute for you as you count the number of times you are able to click the clothespin.
6. Record the result for trial 1 in the table.
7. Rest for 1 minute.
8. Make a new prediction for the number of times you will be able to click the clothespin between your thumb and index finger in your dominant hand for a 1-minute period.
9. Record your prediction for trial 2 in the table.
10. Repeat step 5–7 for trial 2.
11. Repeat step 8–9 for trial 3.
12. Repeat step 5–7 for trial 3.
13. Switch roles with your partner and repeat steps 1–12.
14. Predict what would happen if you used your nondominant hand. Record you prediction in your science journal.
15. Repeat the experiment with your nondominant hand.
16. In your science journal, describe what happened over the course of the 3 trials.
17. Repeat steps 1–19 every other day for 2 weeks (7 more times). Record your data in the Stress This Table.

Stress This*

Segment 1

18. In your science journal, describe what happened over the course of the entire experiment.
19. Graph your results over the 2-week period.
20. Compare the results of the boys and girls in your class. Discuss any similarities and/or differences.

Discussion

1. Compare the number of clicks on the first day to the number of clicks after 2 weeks. Describe any pattern.
2. How did your results compare with your predictions?
3. What does this activity tell you about physical stress and the body?
4. Was there a difference between the boys and girls? Why or why not?

Extension

Based on what you learned from this activity about muscle strength and endurance, do the following activities:

1. Time yourself as you write your full name 10 times. Time yourself again as you write your full name 10 times backwards. Record the time it took you for both trials in your science journal. Why do you think there was a difference in the two times? Practice writing your name backwards several times over the next few days. What happens to the time needed to write your name? Explain any differences between times.
2. In a large, open space, stand with your feet flat on the ground. Long jump as far as you can. Measure the distance you jumped and record it in your science journal. Repeat this activity 3–5 times. What happens to the distance you are able to jump? Practice this jump every other day for a week. Now record the distance you are able to jump. Explain any differences in jumps.
3. Time yourself as you stand on one foot. Stop the timer when you can no longer hold your leg up. Record the time in your science journal. Repeat this activity several times. What happens to the length of time you are able to stand on one foot? Why?

Stress This Table

Date	Trial 1				Trial 2				Trail 3			
	Prediction		Actual		Prediction		Actual		Prediction		Actual	
	Dom	Non	Dom	Non	Dom	Non	Dom	Non	Dom	Non	Dom	Non

(In the table, Non stands for nondominant and Dom refers to dominant.)

* **This hands-on activity was adapted from activities in *From Outer Space to Inner Space/Muscles and Bones: Activities Guide for Teachers* created by Baylor College of Medicine for the National Space Biomedical Research Institute under NASA Cooperative Agreement NCC 9-58. The activities are used with permission of Baylor. All rights reserved. For additional activities visit http://www.nsbri.org/Education/Elem_Act.html**

A Simple Yarn*

Segment 1

Purpose

To examine the structure of skeletal muscles

Materials

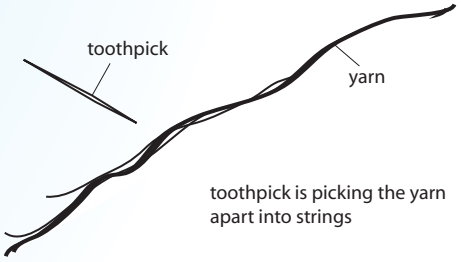
piece of yarn
toothpicks
cooked beef stew meat
plastic knife
tray or plate
magnifying glass
Muscle Investigation Worksheet (p. 27)
ruler
scissors
pencil
science journal
plastic gloves

Background

Even though our skeleton supports our body, we could not stand, balance, or move without muscles. There are over 600 muscles throughout the body. Muscles are responsible for every movement. Muscles are classified as smooth muscle, cardiac muscle, or skeletal muscle. Smooth muscles work automatically without the need to think about or plan the movement. Breathing and blinking are examples of your smooth muscles at work. Cardiac muscles are found only in your heart. These muscles are responsible for making your heart pump. Skeletal muscles follow commands from your brain to help move your bones. When you run, climb, or chew, you are using your skeletal muscles. Movement happens when muscles contract and become shorter. Muscles are made of bundles of fibers that are similar in structure to a piece of yarn. Individual fibers may be easily torn or destroyed, but the bundles help make the muscles stronger and more durable.

Teacher Prep

Cook several cubes (2.5-cm cubes) of beef stew meat. Cool thoroughly. Students may wish to wear plastic gloves when handling the meat.



toothpick is picking the yarn apart into strings

Procedure

1. Using your ruler and scissors, cut a piece of yarn 15 cm long.
2. Examine the piece of yarn with your magnifying glass.
3. Draw a picture of what the yarn looks like in the Yarn Investigation Table.
4. Perform a snap test on the yarn by holding the yarn at both ends and trying to break it by pulling or snapping it.
5. Record the result of the snap test in the Yarn Investigation Table.
6. Using a toothpick, separate the yarn into strands.
7. Observe a strand of yarn with your magnifying glass.
8. Draw a picture of what the strand looks like in the Yarn Investigation Table.
9. Repeat steps 4 and 5 on the strand of yarn.
10. Pull the strand apart into smaller fibers.
11. Observe the fiber with your magnifying glass and illustrate.
12. Place a piece of stew meat on a tray. Observe and note the meat fibers.
13. Using the plastic knife, slice the meat across the grain of the fibers.
14. Draw a top view and a side view of the meat in the Meat Investigation Table.
15. Cut another small piece of meat and try to tear it by pulling in the direction of the muscle fibers and then again across the direction of the fibers. Record your observations in your science journal.
16. Using a new toothpick, separate the meat into as many sizes of fibers within fibers as you can. Draw or describe the fibers in your science journal.

A Simple Yarn*

Segment 1

Discussion

1. Thinking about the snap tests on the yarn, what did you learn about the strength of muscles? Why are muscle fibers "bundled?"
2. In what ways are the meat and yarn similar?
3. In what ways are they different?
4. How do muscles help with physical activity?

Extension

Observe various other types of cooked meat (chicken, pork, or others). Conduct similar tests on these meats. Compare and contrast the meats. Describe how the results are similar and/or different to those you found with the beef stew meat?

Muscle Investigation Worksheet

Yarn Ivestigation

	Appearance	Result of snap test
Yarn		
Strand		
Fiber		

Meat Investigation

Top View	Side View

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As We Are "Jointed" Together*

Segment 1

Purpose

To construct an arm model

To discover the relationship between muscles and bones

To learn about the different kinds of body joints and how they move

Materials

2 rulers with holes for a 3-ring binder
1 paper clip
50-cm string
1 brad
clear tape
protractor
metric ruler
marker
Arm Model Chart (p. 30)
large construction paper
tennis ball cut in half
foam ball slightly smaller than a tennis ball
pencil
science journal

Background

There are three main body parts responsible for moving bones: ligaments, tendons, and muscles. Ligaments are strong, elastic bands of tissue that connect bones together. Tendons are special cords made of tough tissue that attach muscles to bones. Muscles move the bones. These muscles are either attached directly to the bones or by tendons to the bones. Muscles make the joints move by contracting or becoming shorter and pulling two bones closer together. Muscles can only move in one direction. They can only pull, not push. For this reason, muscles must work in pairs. One muscle or group of muscles will bend one part of a joint while a different muscle or muscle group will pull it back to its original position. The place where the muscle is attached to the bone affects the amount of movement the bone can make. There are many muscles for every bone. The movement of a muscle and joint is comparable to a simple machine; for example, the arm is like a lever.

The place where two bones meet is called a joint. Some joints can move, while others do not. Joints that do not move are called fixed joints. Your skull has fixed joints. Moving joints allow you to move your body to walk, eat, and play a video game. Some joints move a lot while other joints move very little. Joints in your spine have very minimal movement. Joints in your arms and legs have a broader range of motion. There are two basic moving joints in the human body: the hinge joint and the ball and socket joint. The hinge joints are in your elbows and knees and allow you to bend and to straighten your arms and legs. The joints are similar to the hinges on a door. Most doors can only open in one direction. It is the same with your arms and legs. They can only move in one direction. There are smaller hinge joints in your fingers and toes. The ball and socket joint is in your shoulders and hips and is made up of a round end of bone that fits into a small, cup-shaped area of another bone. Ball and socket joints allow you to move in more than one direction.

Teacher Prep: Cut a tennis ball in half and remove inside material.

Procedure

1. Place the rulers so that the smooth sides are together.
2. Using the brad, fasten the end holes on both rulers together.
3. Fold the ends of the brad flat against one ruler.
4. Tape only the ends of the brad in place. See diagram 1.

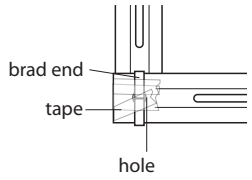

Diagram 1

5. The attached rulers represent the upper and lower arm. The brad represents the joint, or in this case, the elbow.
6. Open the paper clip into the shape of an "S" to make a hook.
7. Place the string on a flat surface.
8. Smooth out one end of the string and measure 5 cm from the end. Mark the distance with a colored marker.

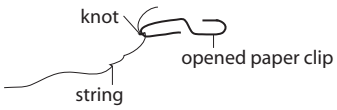

Diagram 2

9. Tie the unmarked end of the string to one end of the paper clip. The paper clip represents a tendon connecting muscle to bone. The string represents a muscle. See diagram 2.
10. Position the arm model into an "L" shape.
11. Place the model on a flat surface, such as a table, so that one ruler lies horizontally and the other ruler is vertical. The joint should rest off the edge of the flat surface to allow the rulers to move freely.
12. Hook the paper clip through the farthest hole from the joint in the ruler resting on the table.

As We Are "Jointed" Together*

Segment 1

13. Thread the marked end of the string through the top hole of the vertical ruler. See diagram 3.
14. Slowly pull the string through the hole in the vertical ruler, stopping at the 5-cm mark. Be sure to hold the elbow joint to keep the rulers steady. The horizontal ruler should rise up off the flat surface.
15. Measure the distance between the tip of the bottom ruler and the flat surface.
16. Record your measurement on the Arm Model Chart.
17. Ask a friend to place a protractor on the table, lining up the center of the protractor with the hinge joint (brad).
18. Measure the angle of the lifted arm and record this measurement.
19. Return the arm model to the "L" position.
20. Move the paper clip into the middle hole of the horizontal ruler.
21. Predict what will happen when you move the string. Record your prediction in your science journal.

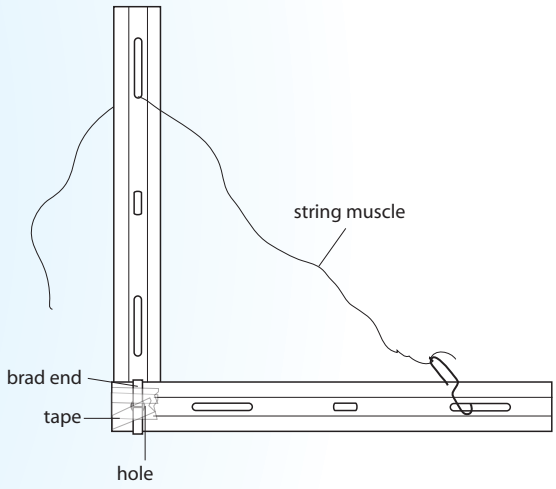

Diagram 3

22. Repeat steps 15–19.
23. Move the paper clip into the hole closest to the joint on the horizontal ruler.
24. Predict what will happen when you move the string. Record your prediction in your science journal.
25. Repeat steps 15–19.
26. In your science journal, draw a picture of the arm model. Use arrows to show the range of motion for a hinge joint.
27. To demonstrate a ball and socket joint, carefully stick the sharp end of a pencil into the foam ball. The pencil and foam ball represent the rounded end of a bone that fits into the socket.
28. Place the foam ball (round bone) into one half of a tennis ball (socket).
29. Practice moving the bone around in the socket.
30. In your science journal, draw a picture of the bone movement. Use arrows to show the range of motion for the ball and socket joint.

Discussion

1. Based on your observations of the arm model, how does the placement of the muscle affect the movement of the bone?
2. Where would you expect the ends of a muscle to be attached if the objective was to achieve the most movement for the least amount of effort? Why?
3. Which joint gives you the greatest range of motion?
4. What are the advantages/disadvantages of a hinge type joint?
5. What are the advantages/disadvantages of a ball and socket joint?
6. Describe the role joints have in physical activity.

As We Are "Jointed" Together*

Extension

1. Devise a way to connect another string muscle to the ruler arm model that would straighten the arm back out. Remember that muscles can only pull, not push.
2. Learn about other joints in the body, such as fixed or unmovable joints and pivot joints. Make models of the different joints and explain how they work.
3. Imagine if your body had only one type of movable joint. What would you be able to do if you only had hinge joints in your body? What would you be unable to do? What could you do if you had only ball and socket joints in your body? What would you be unable to do?

ARM MODEL CHART

Ruler Position	Distance ruler is raised from table (cm)	Angle ruler is raised from table (number of degrees)
Position 1: farthest hole from "joint"		
Position 2: middle hole		
Position 3: closest hole to the "joint"		

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Pairing Up

Segment 1

Purpose

To construct an arm model

To demonstrate the need for muscle groups

Materials

6 sheets of newspaper
metric ruler
masking tape
large safety pin or paper clip
hole-punch
2 long, thin-shaped balloons
string
1 disposable glove
scissors
science journal

Background

Muscles move by contracting. Muscles can only pull, not push. For this reason, muscles must work in pairs to move bones in multiple directions. The biceps and triceps are muscles located in the upper arm. The biceps are attached on one end to a bone in the shoulder and on the other end to a bone just below the elbow. You can feel these muscles in the inside of the upper arm. When they contract, they pull the lower arm up towards the shoulder. The triceps are on the back side of the upper arm. One end of the triceps is attached to a bone in the shoulder, and the other end of the triceps is attached to a bone just below the elbow. You can feel these muscles on the outside of the upper arm. When the triceps contract, they pull the lower arm back down, away from the shoulder. Without the biceps or triceps, the lower arm could not move up and down.

Teacher Prep

Partially inflate two long, thin-shaped balloons. Do not over inflate them because they need to bend easily. Tie the ends of the balloons securely. To make inflation easier, use a hand-held air inflator.

****Caution – Use care when working with balloons. Adult supervision required.**

2 sheets of newpaper cut to length

Humerus

Procedure

1. Estimate the length of your upper arm and the length of your lower arm.
2. Write your estimations in your science journal.
3. Measure the length of your upper arm. Record the measurement in your science journal.
4. Measure the length of your lower arm. Record the measurement in your science journal.
5. To create a model of your arm bones, roll 2 sheets of newspaper together to make a tube. Cut the tube so that it is about the same length as your upper arm bone.
6. Tape the ends of the tube closed with masking tape.
7. Roll 2 more sheets of newspaper to make a second tube and make this tube about the same length as your lower arm bone.
8. Repeat step 7 to make an identical tube for the lower arm. (You should have 3 paper tubes in all.)
9. Put the 2 lower arm bones side by side.
10. Using masking tape, tape the ends of the tubes together so that there is a small space between the two arm bones. See diagram 1.
11. Using the hole-punch, make a hole in one end of the upper arm model.
12. Punch another hole in one end of the lower arm model.
13. Stick the pin or paper clip through the holes to connect the upper and lower arm bone models. See diagram 2.
14. Label the tube for the upper bone "humerus."
15. Label the tube on the lower inside of the arm "ulna."
16. Label the tube on the lower outside of the arm "radius." See diagram 3.

Diagram 1

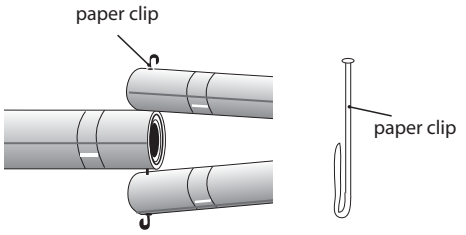


Diagram 2

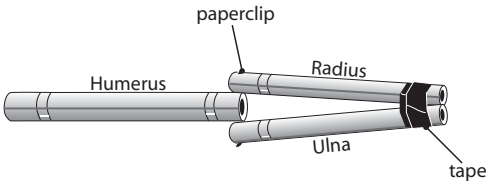


Diagram 3

Pairing Up

17. Get two long, inflated balloons. They represent the upper arm muscles. **Note:** Your arm contains more than two muscles, but for this activity you will only use two to model the movement of the arm muscles.
18. Using string, tie the end of one balloon to the top of the upper arm bone model. This balloon represents the biceps muscle.
19. Tie the other end of the same balloon to the top of the lower arm model just below the elbow. See diagram 4.
20. Tie the second balloon to the top of the upper bone model on the opposite side of the model. This balloon will represent the triceps muscle.
21. Tie the loose end of the balloon to the top of the lower arm model just below the elbow, keeping the balloons parallel. See diagram 5.
22. Attach the disposable glove to the bottom (nonjointed end) of the lower arm bone to represent the hand. See diagram 6.
23. Practice moving the model arm carefully. Observe the joint and the muscles as the model arm moves.
24. Move one of your own arms up and down. With your other hand, feel the movement of the biceps and triceps muscles.
25. In your science journal, describe what you feel. Compare and contrast what you feel to what you see in the arm model.

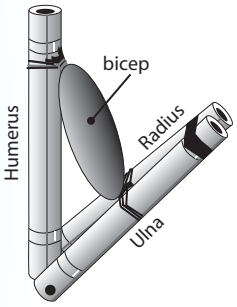


Diagram 4

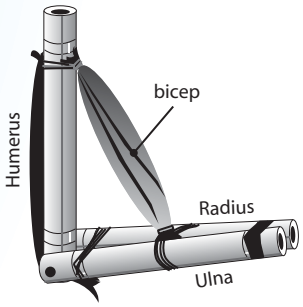


Diagram 5

Discussion

1. What happens to the model biceps when the model arm is lifted? What happens to the model triceps when the arm is lifted?
2. What happens to the biceps and triceps models when the arm is lowered?
3. What do you think would happen if you attached the model muscle (the balloon) farther down on the lower arm bone model? Higher up?

Extension

1. Reattach the ends of the model muscle on the lower arm bone model. Try different locations both higher and lower on the lower arm bone model. What happens when the model muscle is attached lower and higher? Why?
2. Look at your lower arm as you wiggle your fingers. Observe the muscles move as you wiggle your fingers. Illustrate the muscle movement.
3. Conduct research to learn more about the muscular and skeletal systems. How do these two systems work together?
4. Create a class chart to compare the arm bone measurements of all students. Make a table or graph to display the data. Compare the class data you collected to find any correlations between boys, girls, height, or other traits and characteristics.

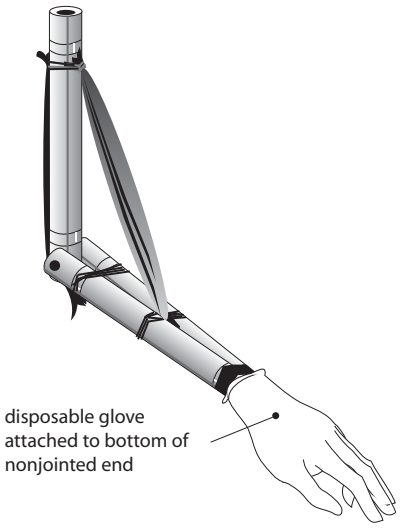


Diagram 6

Answer Key

Segment 1

Let's Get Physical

1. Answers will vary, but students should conclude that value is demonstrated by an increased involvement in physical activities.
2. Answers will vary.
3. Answers will vary but may include the following: Physical activity can help tone muscles, burn extra calories, build healthy bones, and help control your appetite. People who are physically active tend to have more energy, are better able to deal with stress, and have a better body image. Physical activity can help lower the risk of heart disease.
4. Answers will vary.
5. Answers will vary, but may include riding a bicycle, swimming, playing sports, or running.

Pumping Up the Stress

1. Your heart rate is slowest when sitting or resting. It will be fastest during high levels of physical activity.
2. Yes. As you increase your level of physical activity, the body needs more oxygen, so the heart must pump faster to bring that oxygen to the cells that need it.
3. Your heart rate will increase as the physical activity begins, but it will reach a plateau. It will continue beating at the faster rate to supply oxygen to the body; however, your heart rate will not continue to climb.
4. Answers will vary.
5. Aerobic activity helps to keep our heart and body healthy. It literally pumps energy around the body. As the pulse rate rises, an increase in blood and oxygen is supplied to muscles and vital organs. Endorphin levels rise, helping to calm the mind. Metabolism increases as well. Aerobic activity conditions the heart and skeletal muscles, making us more efficient at using energy.

Stress This

1. The number of clicks should increase throughout the 2-week period.
2. Answers will vary.
3. The activity explains that muscle endurance and strength are increased by frequently requiring muscles to perform the same task. The muscles become better at completing the task and can perform the task for longer periods of time without becoming tired or weak.
4. Answers will vary. Differences may be seen most among groups that are involved in physical activities that require the use of their hands.

A Simple Yarn

1. The snap test showed that the greater the number of fibers, the greater the strength of the muscle. As you pulled the muscles apart, it took less and less energy to break the strands. Muscles have to be strong to contract and lift the bones, making movement possible. Without the extra strength of the muscle fibers, a task as simple as picking up a book might cause a muscle to tear.
2. Both the yarn and the meat are made up of smaller strands and fibers that are bound together to make them stronger.
3. The meat fibers are actually muscle tissue that stretches, allowing the fibers to contract or shorten to do their job. These meat muscles are bundles of fibers packaged inside one another. Each bundle is filled with hundreds of even smaller strands. The yarn fibers are not very elastic; they hold the same shape. Yarn fibers are the same size, woven together to make a thicker strand.
4. Muscles help the body stand, balance, and move. Smooth muscles work automatically to help with functions such as breathing, and cardiac muscles keep your heart beating.

As We Are "Jointed" Together

1. The farther from the joint that the muscle is attached, the smaller the amount of bone movement; however, the closer the muscle is attached to the joint, the greater the effort needed to move the bone.
2. Answers will vary, but students should understand that muscle placement balances the movement of the bone with the effort of the muscle, so large amounts of movement can occur with a relatively small amount of contraction.
3. A ball and socket joint gives the greatest range of motion.
4. A hinge joint provides strength and stability but only allows movement in one swinging direction.
5. A ball and socket joint gives the user more flexibility, allowing movement in several directions, but does not provide stability. If your knees, for example, were ball and socket joints, your lower legs would move all around but would not be stable enough to hold up your body.
6. Joints provide a way for the bones to move in different directions so that activities like riding a bicycle or throwing a ball are possible.

Pairing Up

1. As the model is raised, the biceps muscle will contract and become relaxed and loose while the triceps muscle is stretched tightly.
2. When the arm is lowered, the opposite occurs. Now the biceps muscle is stretched tightly and the triceps muscle contracts and becomes relaxed and loose.
3. Answers will vary, but students should understand that the muscle is attached in a place that provides the most efficient movement. Changing the location of the muscle will change the amount of movement allowed and the amount of energy required to move the bone.

On the Web

Calling All Body Parts

1. Body systems work together, like a machine, to make physical movement possible. Muscles and joints move bones; bones support the body as it moves; the heart pumps oxygen-rich blood throughout the body, supplying energy for movement.
2. Answers will vary, but students should understand that some organs are essential, like the heart, but that physical activity is still possible if one is missing a leg or a finger.
3. The President's Council on Physical Fitness reminds us to be physically active every day, to eat a nutritious diet, to get preventative screenings, and to avoid risky behaviors.

The NASA SCI Files™

The Case of the Physical Fitness Challenge

Segment 2

Back at the tree house, RJ and Kali dial up Dr. Scott Smith at NASA Johnson Space Center in Houston, Texas, who explains how muscles and bones work together in the musculoskeletal system. He also makes clear the importance of nutrition and physical activity for the growth of healthy bones and explains why astronauts must continue to exercise in space to maintain bone health. Deciding that bones are an important part of being physically fit, RJ and Bianca check out the NASA SCI Files™ Kids' Club to learn more, and they dial up a classroom in Dundee, Scotland. Mr. David Shand's class at the Harris Academy has just finished conducting an experiment on how calcium loss affects bones. The detectives begin to realize that nutrition plays an important role in being physically fit and staying healthy. They decide to contact a doctor to learn more about nutrition. Bianca is on her way to Washington, D.C. and is able to get an appointment with Vice Admiral Richard H. Carmona, M.D., M.P.H., FACS, the U.S. Surgeon General! Vice Admiral Carmona explains what nutrients are and why they are important to good health. Meanwhile, back at Dr. D's lab, Dr. D explains that a calorie is a unit of measure that tells us the amount of energy stored in food and how our bodies combine oxygen with nutrients to produce energy. The detectives are sure they are on the right track but realize that there is much more to learn.

Objectives

Students will

- understand the role of bones in the body.
- learn how the design of bones makes them strong.
- examine a real bone.
- compare the amount of calcium needed by the body at different developmental stages.
- demonstrate the effect of calcium loss on bones.
- prove the importance of calcium in building and maintaining strong bones.
- calculate the amount of calcium consumed daily.
- determine which kinds of fruits contain the largest amount of vitamin C.
- identify the function of vitamins and minerals that are important to a healthy body.
- plan a nutritionally balanced snack.
- design a realistic nutrition label.
- explain how the small intestine works to break food into nutrients and to absorb them.

Vocabulary

bone marrow – soft tissue filling the spongy inside of bones; the purpose of bone marrow is to make new blood cells

calorie – a unit of measure that tells us the amount of energy stored in food

carbohydrates – a large group of compounds that includes sugars and starches, which are made naturally by plants and are one source of food energy (calories)

fat – an oily substance found in foods that is a source of energy (calories); excess fat is stored by the body and may cause health problems

ligaments – a strong band of white fibrous tissue that connects bones and cartilage

macronutrients – groups of nutrients, such as carbohydrates, proteins, and fats that provide energy and make up the bulk of the diet (nutrients required in small amounts are called micronutrients)

metabolism – all chemical processes of a living body; metabolism is influenced by exercise, food, and temperature

musculoskeletal system – network of bones and muscles that work together to move the entire body

nutrients – materials in foods that people need to grow and stay healthy

osteoporosis – a bone-thinning disease in which the levels of calcium in the body drop below what is needed, resulting in weakened bones and an increased risk of fractures or breaks

proteins – compounds that are very important for almost all parts of the body; also a source of food energy (calories)

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Prior to viewing Segment 2 of *The Case of the Physical Fitness Challenge*, discuss the previous segment to review the problem and reaffirm what the tree house detectives have learned thus far. Download a copy of the **Problem Board** from the NASA SCI Files™ web site, select **Educators**, and click on the **Tools** section. The **Problem Board** is also in the **Problem-Solving Tools** section of the latest online investigation. Have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 1 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have occurred during Segment 1. Use tools located on the Web, as was previously mentioned in Segment 1.
4. Review the list of ideas and additional questions that were created after viewing Segment 1.
5. Read the Overview for Segment 2 and have students add any questions to their lists that will help them better understand the problem.
6. **Focus Questions**—Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes while viewing the program to help them answer the questions. An icon will appear when the answer is near.

Video Component

7. **"What's Up?" Questions**—These questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. They can be printed from the web site ahead of time for students to copy into their science journals.

View Segment 2 of the Video

For optimal educational benefit, view *The Case of the Physical Fitness Challenge* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" Questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Have students work in small groups or as a class to discuss and list what new information they have learned about nutrition and physical fitness.
4. Organize the information and determine whether any of the students' questions from the previous segments were answered.
5. Decide what additional information is needed for the tree house detectives to determine the importance of bones and muscles on physical fitness and the role of nutrition in a healthy lifestyle. Have students conduct independent research or provide students with information as needed. Visit the NASA SCI Files™ web site for an additional list of resources for both students and educators.
6. Choose activities from the **Educator Guide** and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.
7. For related activities from previous programs, download the appropriate Educator Guide. On the NASA SCI Files ™ home page, select the fence post that says "Guides." Click on the **2002–2003 Season** tab and then click on *The Case of the Disappearing Dirt©*. In the green box, click on **Download the Educator Guide**.

   a. In the **Educator Guide** you will find

      a. Segment 1 – *There's Iron in my Cereal*, page 26

   Click on the **2004–2005 Season** tab and then click on *The Case of the Great Space Exploration©*. In the green box, click on **Download the Educator Guide**.

   b. In the **Educator Guide** you will find

      b. Segment 2 – *Boney Bones*, page 35

8. If time did not permit you to begin the web activity at the conclusion of Segment 1, refer to number 6 under **After Viewing** on page 15 and begin the Problem-Based Learning activity on the NASA SCI Files™ web site. If the web activity was begun, monitor students as they research within their selected roles, review criteria as needed, and encourage the use of the following portions of the online, Problem-Based Learning activity:

   Research Rack—books, internet sites, and research tools

   Problem-Solving Tools—tools and strategies to help guide the problem-solving process

   Dr. D's Lab—interactive activities and simulations

   Media Zone—interviews with experts from this segment

   Expert's Corner—listing of Ask-An-Expert sites and biographies of experts featured in the broadcast

9. Have students write in their journals what they have learned from this segment and from their own experimentation and research. If needed, give students specific questions to reflect upon as suggested on the **PBL Facilitator Prompting Questions** instructional tool found by selecting **Educators** on the web site.
10. Continue to assess the students' learning, as appropriate, by using their journal writings, problem logs, scientific investigation logs, and other tools that can be found on the web site. For more assessment ideas and tools, go to **Educators** and click on **Instructional Tools** in the menu bar.

Careers

dietician
health teacher
NASA researcher
NASA scientist
nurse
occupational therapist
physical therapist
Surgeon General

Resources *(additional resources located on web site)*

Books

Lombardo, Michelle: *Organwise Guys – Learning to Be Smart from the Inside Out!* Wellness, Incorporated, 1996, ISBN: 096484382X.

Needham, Kate: *Why Do People Eat?* Usborne Books, 1993, ISBN: 0746013027.

Petrie, Kristin: *Vitamins Are Vital.* ABDO Publishing Company, 2003, ISBN: 1591974062.

Royston, Angela: *Vitamins and Minerals for a Healthy Body.* Heinemann Library, 2003, ISBN: 1403407584.

Royston, Angela: *Why Do Bones Break? and Other Questions about Bones and Muscles.* Heinemann Library, 2002, ISBN: 1403402019.

Showers, Paul: *What Happens to a Hamburger?* HarperCollins Publishers, 2001, ISBN: 0064451836.

Silverstein, Alvin and Silverstein, Virginia: *Eat Your Vegetables! Drink Your Milk!* Scholastic Library Publishing, 2000, ISBN: 0531165078.

Simon, Seymour: *Bones: Our Skeletal System.* HarperCollins Publishers, 2000, ISBN: 0688177212.

Video

NASA Center for Distance Learning: *NASA SCI-Files: The Case of the Biological Biosphere*© (2003)
Grades 3–5

Discovery Channel: *Bodies on the Mend* (2004)
Grades K–5

Discovery School: *An Inside Look at Broken Bones* (1997)
Grades 5–12

Educational Video Network: *What Are Nutrients?* (1996)
Grades 4–7

Eyewitness: *Skeleton* (1994)
Grades 4–8

Web Sites

Dundee, Scotland
Scotland's fourth largest city, Dundee, offers a warm welcome and a fascinating range of things to see and do.
http://www.visitscotland.com/aboutscotland/cities/cityofdundee

KidsHealth
This site has a wealth of information on topics such as staying healthy, the importance of eating healthy food, the new food guide pyramid, carbohydrates, proteins, vitamins, minerals, the importance of drinking water, the joys and benefits of physical activity, the human body, muscles, and body systems. All information is presented in a kid friendly format.
http://www.kidshealth.org/kid/

Calcium! Do You Get It?
On this U.S. Food and Drug Administration and Center for Food Safety and Applied Nutrition web site, learn about the importance of calcium to the body, including ways to increase your calcium. This site is aimed at girls ages 11–14.
http://vm.cfsan.fda.gov/~dms/ca-toc.html

National Institute of Child Health and Human Development
Play fun games on this kid friendly site to learn all about calcium and its benefit to the body.
http://www.nichd.nih.gov/milk/kidsteens.cfm

Calcium – Texas A&M University
Visit this interactive web site for a calcium adventure complete with a scavenger hunt of shopping, playing games, and gathering clues!
http://calcium.tamu.edu/

Powerful Bones. Powerful Girls. – The National Bone Health Campaign
This Center for Disease Control and Prevention web site is a kid-friendly, interactive site that educates girls about the benefits of staying healthy and getting enough calcium.
http://www.cdc.gov/powerfulbones/index_content.html

The Dairy Council of California
This web site is designed to assess the activity level of teenagers but can be used for anyone. NOTE: The site does ask for your name, age, and gender; however, the site claims to comply with the Children's Online Privacy Protection Act. It is recommended that you give only your first name. There is also a teachers' link for lesson plans and further information.
http://www.dairycouncilofca.org/activities/pfp/pfp_main.htm

Cabot Cheese
Visit this web site to learn more about calcium, the food pyramid, healthy bones, and nutrition in general. Find out about several free community programs such as a patch for Girl Scouts and scripts for the drama club.
http://www.cabotcheese.com/

Cabot Cheese—Ag in the Classroom
"Ag in the Classroom" is a free educational resource for grades K–8 that includes videos and a teacher guide. Challenge your students to learn about the power of persuasion, nutrition, and advertising and discover everything from how much a cow eats to fascinating careers in agriculture.
http://www.cabotcheese.com/f1.tmpl?left=menu-education.html&right=EdAndFun.html

Cabot Cheese—Calcium Crisis Challenge
Teachers may register their schools to take the Cabot Calcium Crisis Challenge. Rules for the challenge, necessary forms, including judging sheets, and media advisory letters are included. Students will complete research and prepare presentations to help educate others about the importance of calcium. An extensive collection of resources about calcium is listed at the bottom of the page and may be reached without registering for the challenge by simply scrolling down and clicking on the resources link.
http://www.cabotcalciumchallenge.com/

State of Missouri: Governor's Council on Physical Fitness and Health
Take a virtual tour of the human body and complete activities to learn more about the body and its parts.
http://www.mofitness.org/BodyWalk/

Human Adaptation and Countermeasure Office
Visit this kid-friendly NASA Johnson Space Center web site to learn more about nutrition and the human body. Download Space Nutrition newsletters that contain fun facts, experiments, and web challenges to learn about topics, such as vitamin D, the solar powered vitamin, rats and vitamin K, and what happens when our bodies oxidize.
http://haco.jsc.nasa.gov/biomedical/nutrition/newsletter.shtml

United States Department of Health and Human Services
Go to this site to learn about America's chief health educator, the Surgeon General, who gives Americans the best scientific information available on how to improve health and reduce the risk of illness and injury.
http://www.surgeongeneral.gov/

United States Food and Drug Administration (USDA)
Visit this web site to learn about the job of the USDA. Read about recent Food and Drug Administration news and how they regulate food and drugs in our country to keep Americans safe.
http://www.fda.gov/

Cool Food Planet
Explore this kid-centered web site to learn about health and nutrition. Enjoy informative activities and quizzes as you learn about ways to stay healthy.
http://www.coolfoodplanet.org/gb/kidz/

Nutrition Explorations
This site has activities and information for educators, parents, and kids. There are lots of games and activities to help you learn about nutrition.
http://www.nutritionexplorations.org/

Nutrition Café
Learn all about nutrition through fun and interactive games sponsored by the Pacific Science Center and the Washington State Dairy Council. Evaluate the healthiness of a meal or help the nutrition detective find the missing nutrients.
http://exhibits.pacsci.org/nutrition/nutrition_cafe.html

How Stuff Works
Travel to this web site to learn about vitamins and how they work.
http://www.howstuffworks.com/question129.htm

Activities and Worksheets

Putting on the Bone*

Segment 2

Purpose

To understand the role of bones in the body

To learn how the design of bones makes them strong

To examine a real bone

Teacher Prep

Cook the chicken bones ahead of time and remove all meat. Soak bones for 5 minutes in a 1:10 bleach/water solution. Cut or break half the bones into two pieces and leave the other half whole.

Background

Bones not only give the body support and protection, they are also light enough to make moving your body easy. Although bones look solid from the outside, they are not. If they were completely solid, they would be too heavy and hard to move. Bones are made of different layers. The hard, outer layer is made of living cells. Minerals such as calcium and phosphorus surround the cells, giving the bones their strength. A thick membrane of soft tissue that protects the hard outer layer covers the bones inside your body. This membrane helps heal damaged bone tissue. Underneath the hard outer layer of bone is a spongy layer. The spongy layer is hard as well but is called spongy because it has an open structure filled with tiny holes. Bone centers have a hollow cavity. The cavity contains a special tissue called bone marrow. Blood vessels run through the marrow, carrying food and oxygen to the bone cells and taking away waste. Bones contain two types of marrow. Red marrow produces blood cells and yellow marrow is made of fatty tissue cells that can convert to energy when your body runs low on fuel. Bone marrow looks similar to thick jelly.

Materials

(Per Group)
- 2 150 mL (5 oz) nonreinforced paper cups
- 6–10 heavy hardback books
- dried beans
- large sheet of corrugated cardboard
- metric ruler
- marker
- clay
- toothpicks
- science journal
- bathroom scale
- 2 long chicken leg or thigh bones

(Per Student)
- Weight Chart Worksheet
- safety goggles
- gloves
- magnifying glass
- paper plates

Procedure

Part 1

1. Using clay, build a clay person about 15–30 cm tall.
2. Without sticking the clay to a hard surface, try to get the clay person to stand unaided.
3. Release the clay person and observe. Record your observations in your science journal.
4. Rebuild your clay person, this time using toothpicks inside the clay to represent the bones in the body. See diagram 1.
5. Repeat steps 2 and 3.
6. On the sheet of cardboard, use a ruler to find and mark the center point. Make the mark very dark. See diagram 2.
7. Place an empty cup right side up on a flat surface. This cup will represent a hollow bone. See diagram 3 on page 42.
8. Place the cardboard on top of the cup with the center mark over the center of the cup.
9. Predict how many books can be stacked on top of the cup before it collapses. Record your prediction on the Weight Chart Worksheet.
10. Estimate the weight of the books and enter in the chart the estimated predicted amount of weight the cup can support.
11. Begin stacking the hardback books on the cup, one at a time. Make sure to center them over the center mark on the cardboard.
12. Keep stacking books until the cup collapses.
13. On the Weight Chart Worksheet, record the number of books it took to collapse the cup.
14. Use the bathroom scale to weigh the books. Record the weight in pounds on the Weight Chart Worksheet.
15. Repeat the experiment (steps 7–14) two more times.

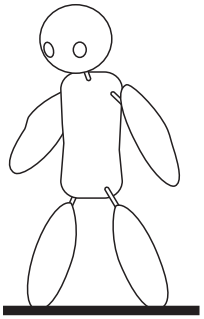


Diagram 1

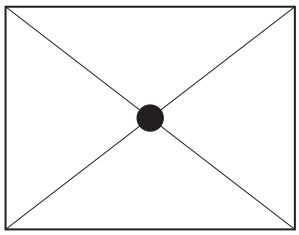


Diagram 2

Putting on the Bone*

16. Calculate the average amount of weight the cup held. To calculate, add the three weights and divide the total by three.
17. Fill one cup completely with the dried beans. This cup will represent a solid bone filled with the spongy hard layer.
18. Place the filled cup on a flat surface.
19. Repeat steps 8–17.
20. In your science journal, record your observations and describe what you learned during the experiment.

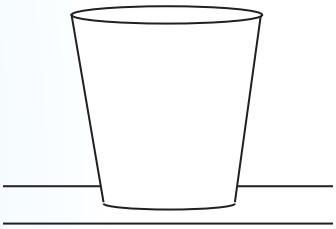


Diagram 3

Part 2

21. Put on safety goggles and gloves.
22. Place a whole chicken bone on a paper plate.
23. Examine the chicken bone by using your eyes only.
24. In your science journal, illustrate the bone.
25. Examine the chicken bone with the magnifying glass.
26. In your science journal, illustrate the bone under magnification.
27. Discuss and predict what the inside of the bone will look like.
28. Draw your prediction in your science journal.
29. Place a chicken bone that has been cut in half on a paper plate.
30. Repeat steps 23–26.
31. Properly dispose of the gloves.
32. Immediately wash hands thoroughly with soap and water.

Discussion

1. Describe the difference between the clay person without "bones" and the clay person with "bones."
2. Why do you think the skeleton is important to the human body?
3. Which cup held the most weight? Why do you think it was able to hold more weight?
4. Which cup is most like the bones in your body? Why?
5. What did you observe when you examined the chicken bones? How did the inside of the actual bone compare to your prediction?

Extension

1. Examine a sponge with your eyes and with a magnifying glass. How is a sponge similar to the inside of a bone? How is it different? Fill one of the cups with cut up pieces of sponge. Stack the books on top of the cup. How many books was this "bone" able to hold?
2. Obtain X-rays from a local physician or hospital. Look at the pictures. What can you tell about the bones from the X-rays? Conduct research to learn more about X-rays.
3. Tape flat objects such as leaves, coins, or washers to the bottom of a sheet of paper. Overlap the items. Turn the paper over and use a pencil or crayon to make a rubbing of the items. Carefully remove the items from the back of the paper. Show the rubbing to someone else and have them guess which items you used to make the drawing. Explain how this picture is similiar to an X-ray.

* **This hands-on activity was adapted from activities in *From Outer Space to Inner Space/Muscles and Bones: Activities Guide for Teachers* created by Baylor College of Medicine for the National Space Biomedical Research Institute under NASA Cooperative Agreement NCC 9-58. The activities are used with permission of Baylor. All rights reserved.**

For additional activities visit http://www.nsbri.org/Education/Elem_Act.html

Putting on the Bone*

WEIGHT CHART WORKSHEET

	Prediction for Number of Books Supported	Actual Number of Books Supported	Prediction for Weight Supported	Actual Weight of Books Supported
Hollow Bone				
Trial 1				
Trial 2				
Trial 3				
Average				
Solid Bone				
Trial 1				
Trial 2				
Trial 3				
Average				

Hole-y Bones

Segment 2

Purpose

To compare the amount of calcium needed by the body at different developmental stages

To demonstrate the effect of calcium loss on bones

Materials

2 bags of flour (approximately 5 kilograms)
scale to measure grams
6 large, zippered plastic bags
marker
science journal
copy paper
scissors
pencil
single hole-punch
Bone Data Worksheet (p. 46)
calculator (optional)

Background

Calcium is an important mineral that helps build and maintain strong bones and teeth. If calcium were removed from the body, it would resemble flour. The amount of calcium in your body will change throughout your life. Newborn babies have only about 30 grams of calcium. By age 10, the amount of calcium has increased to nearly 420 grams. As the bones continue to grow, the amount of calcium in the body continues to increase. By age15, the amount of calcium will have doubled from that of a 10 year old to 840 grams. By the time children reach adulthood, the bones will contain 44 times as much calcium as they did when they were born, or nearly 1,320 grams. Physical activity also helps build strong bones. The good stress on the bones created from physical activity is particularly important during the bone growing years. After age 25, the bones stop growing and are as big as they will ever be. But the needs for calcium and physical activity do not stop. Bones lose about 1% of the total amount of calcium in the body each day. Because calcium is absorbed by the body in small quantities, it is important to take in additional amounts of calcium throughout the day. When the body does not get enough calcium, bones have a higher risk of fracture or breaking. Osteoporosis is a disease in which levels of calcium in the body drop so much that the bones begin to thin and weaken. Osteoporosis in adults cannot be detected until the bone loss is between 30 and 40%, making the bones very fragile. Astronauts who spend more than 180 days in space lose about 20% of their bone mass. Getting the recommended daily amount of calcium and being physically active will help keep bones healthy throughout life.

Procedure

Part 1

1. Using the scale, measure 30 g of flour.
2. Pour the flour into a zippered bag. Be sure to seal it completely.
3. Using the marker, label the bag "Newborn Child – 30g" and record in the Bone Data worksheet.
4. Measure 420 g of flour and put it into a bag.
5. Label the bag "Age 10 – 420 g" and record.
6. Measure 840 g of flour and put it into a bag.
7. Label the bag "Age 15 – 840 g" and record.
8. Measure 1,320 g of flour and put it into a bag.
9. Label the bag "Adult – 1,320 g" and record. See diagram 1.
10. To calculate the calcium of an adult suffering from osteoporosis
    a. Multiply 1,320 times 40%
    b. Subtract your answer from 1,320
    c. Record the answer in the Bone Data Worksheet.
    d. Round your answer to the nearest whole number and record.
11. Measure this amount of flour and put it into a zippered bag.
12. Label the bag "Adult with osteoporosis – ____ g."
13. To calculate how much calcium an astronaut loses after being in space for a long period of time
    a. Astronauts lose about 20% of their bone mass while in space
    b. Multiply 1,320 times 20%

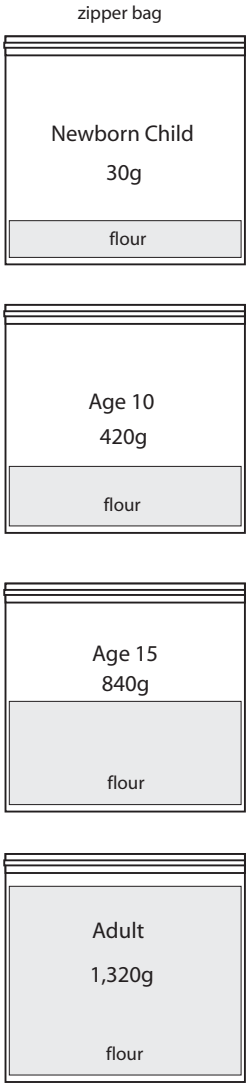


Diagram 1

Hole-y Bones

Segment 2

c. Subtract the answer from 1,320.

d. Record the answer in the Bone Data Worksheet

e. Round your answer to the nearest whole number and record

14. Measure this amount of flour and put it into a zippered bag.
15. Label the bag, "Astronaut on long–duration space flight--____ g."
16. Look at the data in the Bone Data Worksheet. Compare the amount of flour in each bag. How do they compare?
17. To calculate how much calcium your body loses per year at each stage, take each measurement and multiply it by .01 (1%).
18. Record the answers in the Bone Data Worksheet.
19. Round the answers to the nearest whole number and record in the Bone Data Worksheet.

Part 2

20. Stack three sheets of paper together and fold them in half, lengthwise.
21. Keeping the papers folded, draw a tibia (lower leg bone) or femur bone (upper leg bone) on the top paper, filling the half sheet. See diagram 2.
22. Keeping the papers folded so that the bone you drew is on top, cut through all sheets to create six bones that are exactly the same.
23. Choose one bone to be the control bone and firmly grasp each end of the paper bone with both hands. See diagram 3.
24. Tug on both ends of the bone, creating stress in the center of the paper bone.
25. Count each tug and continue to tug until the paper bone breaks. If it doesn't break, stop after 40 tugs and record 40+ tugs.
26. Record the number of tugs in the Bone Data Worksheet.
27. Select a second paper bone to represent the bone of a 10 year old.
28. Looking at your bone loss chart, find the amount of calcium loss, rounded to the nearest whole number for a 10 year old.
29. Use a hole-punch to punch that number of holes in the center, long shaft of the bone. See diagram 4.
30. Tug on the bone, as before, being sure to count each tug.
31. Record how many tugs it took to break the bone on the Bone Data Worksheet.
32. Repeat for each of the remaining categories: 15-year old, adult, adult with osteoporosis, and astronaut. Make sure to punch the number of holes in the paper bone that corresponds to the grams of calcium lost.
33. Record your findings for each bone.

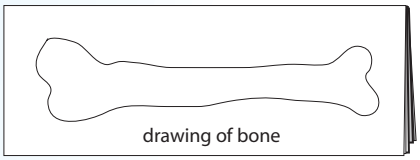


Diagram 2

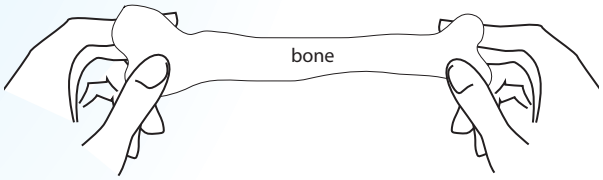


Diagram 3

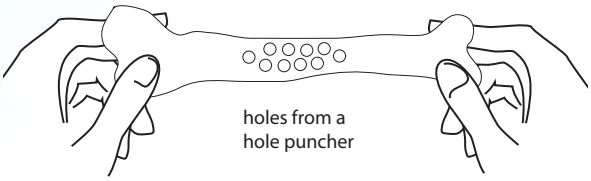


Diagram 4

Discussion

1. Why is calcium important to bones?
2. What happens to bone strength as bone mass is lost?
3. How much calcium is recommended for someone your age?
4. What can you do to prevent bone loss?

Hole-y Bones

Extension

1. A smoothie is a delicious, nutritious snack that is also a great source of calcium. A basic smoothie contains 118 mL (1/2 cup) to 177mL (3/4 cup) milk, 59 mL (1/4 cup) to 118 mL (1/2 cup) frozen yogurt or ice cream, and any combination of fruits, cinnamon, cocoa, chocolate syrup, oatmeal, vanilla extract, honey, peanut butter, and juice concentrates. With adult supervision, blend these ingredients or others you like to create your own smoothie.
2. Research to find the amount of calcium in your smoothie. Create a nutrition label for your smoothie. Produce an ad to promote it.
3. In class, have each group create a unique smoothie. Share a small amount with other classmates. Rate each group's smoothie for taste and calcium value.
4. Conduct research to learn what the recommended daily allowance is for calcium during each stage of development.
5. Research to find which foods are rich in calcium.
6. Keep a chart that shows how many foods you are eating that are good sources of calcium.

BONE DATA WORKSHEET

Age	Grams	Calcium loss (in grams)	Calcium loss (in grams rounded to nearest whole number)
Newborn			
10			
15			
Adult			
Adult with Osteo-porosis			
Astronaut on long-duration flight			

Bone	Number of holes punched (each hole = 1 gram of calcium)	Number of tugs to break bone
1 – Healthy Bone (control)	- 0 -	
2 – 10 year old		
3 – 15 year old		
4 – adult		
5 – adult with osteoporosis		

Bendy Bones

Segment 2

Purpose

To prove the importance of calcium in building and maintaining strong bones

Materials

- 4 similarly cooked chicken bones (with all meat removed)
- vinegar (approximately 1.5 liters (L))
- 4 jars with tight sealing lids
- safety goggles
- gloves
- water
- protractor
- permanent marker
- access to a sink
- Bendy Bones Worksheet p. 48

Background

Our bones get their strength from a hard outer covering that contains the mineral calcium carbonate. The calcium keeps the bones stiff and rigid. The human body needs calcium for building healthy teeth and bones. Without this mineral, our bones would be soft and flexible. Because teeth and bones grow the most during childhood and adolescence, it is especially important for kids to get enough calcium. The more bone mass children can accumulate during these years, the less likely they are to develop serious bone problems in the future. Bones lose calcium over time, so the calcium must be replaced daily. Children, ages 4–8, need 800 mg of calcium per day, while those ages 9–18 need 1,300 mg per day. Consistent low levels of calcium can cause health problems, including the increased likelihood of broken bones, unhealthy teeth and gums, and rickets. As an adult, these low levels can cause osteoporosis, a painful condition caused by a decrease in bone density that often leads to broken hips and other fractures in the elderly. Eating a well balanced diet that includes foods rich in calcium is an important way to keep bones healthy. In this activity, vinegar, an acid, will slowly dissolve the calcium in the bones, making the bones weak.

NOTE: This experiment will take place over 3 weeks.

Procedure

1. Wear your safety goggles and gloves whenever you are performing this activity.
2. Place one chicken bone in each of the four jars.
3. Label the first jar "control."
4. Label the second jar "Vinegar – 1 Week."
5. Label the third jar "Vinegar – 2 Weeks."
6. Label the fourth jar "Vinegar – 3 Weeks."
7. To the "control" jar, add water to completely cover the bone.
8. To the other three jars, add vinegar to completely cover the bones.
9. Put the lids on all four jars and tighten them securely.
10. Place the jars in a safe place. Dispose of gloves properly.
11. After one week, get the "Control" and "Vinegar – 1 Week" jars.
12. Put on your safety goggles and gloves.
13. Remove the bone from the "Control" jar.
14. Rinse the bone off with water from the sink.
15. Try to bend the bone.
16. Use a protractor to measure how much the bone bends with reasonable force. See diagram 1.
17. Record your results on the Bendy Bones Worksheet.
18. Remove the bone from the "Vinegar – 1-Week" jar.
19. Repeat steps 14–17.
20. Put the control bone back in the control jar, tighten the lid, and return the jar to a safe place.
21. Properly dispose of the gloves and contents of the vinegar jar. NOTE: Jars MUST be sanitized before reusing.
22. After the second week, get the "Control" and "Vinegar – 2-Weeks" jars.

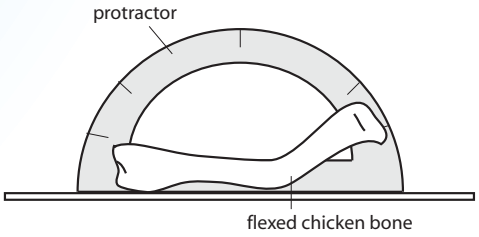


Diagram 1

Bendy Bones

23. Put on your safety goggles and gloves.
24. Repeat steps 13–17.
25. Remove the bone from the "Vinegar – 2-Weeks" jar.
26. Repeat steps 14–17.
27. Put the control bone back in the control jar and return it to a safe place.
28. Properly dispose of the gloves and contents of the vinegar jar and sanitize jar before reusing.
29. After 1 more week, get the "Control" and "Vinegar – 3 Weeks" jars.
30. Put on your safety goggles and gloves.
31. Repeat steps 13–17.
32. Remove the bone from the "Vinegar – 3 Weeks" jar.
33. Repeat steps 14–17.
34. Properly dispose of the gloves and contents of the control and vinegar jars and sanitize jars before reusing.

Discussion

1. Which bone was the strongest? Weakest? How do you know?
2. What effect does the vinegar have on the calcium in the bones?
3. As the amount of calcium in a bone decreases, what happens to the bone? How do you know?
4. What are some of the long-term effects of calcium loss?

Extensions

1. Repeat the activity again to see if you get the same results. How did your results from the two trials compare? Why is it important for scientists to do more than one trial?
2. Ask a local dentist for fluoride. Get two eggs, two jars with tight lids, vinegar, and a paintbrush. Put on your safety goggles and gloves. Fill one jar with vinegar and place an egg in it. Seal the lid tightly and label this jar "control." Fill the other jar with vinegar. Using the paintbrush, coat the outside of the other egg with fluoride. Place the egg in the vinegar. Seal the lid tightly on the jar and label it "fluoride." Wait 2–3 days and check the eggs. Remember to wear your safety goggles and gloves. What do you notice about the two eggs? Put the eggs back into the proper jars and allow more time to pass to see if any additional changes occur. Why is fluoride important to keeping teeth healthy?

BENDY BONES WORKSHEET

Bone In:	Degrees Bones Bend After 1 Week	Degrees Bones Bend After 2 Weeks	Degrees Bones Bend After 3 Weeks
Water (control)			
Vinegar			

Counting the Calcium*

Segment 2

Purpose

To calculate the amount of calcium in your diet

Materials

Calcium Calculator Worksheets (p. 51)
pen or pencil
science journal
calculator (optional)
computer with Internet access

Background

Calcium is necessary to build strong bones and teeth, regulate the heartbeat, clot the blood, maintain proper thyroid function, and help transmit nerve impulses. Calcium is the most abundant mineral in the human body. The teeth and bones contain 99% of the body's calcium. Because new bone is constantly being formed and broken down, the body needs a regular calcium supply. Peak bone growth occurs between the ages of 12 and 25. Getting the recommended daily amount of calcium is critical during these growing years, but the body never outgrows its need for calcium.

Osteoporosis is a disease in which bones become weak and fragile. Because the bones are not as strong, they are more likely to break. These breaks, or fractures, usually occur in the hips, spine, and wrists. Often these breaks are very painful and do not heal fully. Getting the daily recommended amount of calcium early in life can help prevent the development of osteoporosis. Unfortunately, the National Health Institute reports that only 19% of teenage girls and 52% of teenage boys are getting the recommended amounts of calcium per day.

Vitamin D is also important to healthy bone growth. Vitamin D helps the body absorb the calcium that is consumed. Milks and cereals (and some orange juice) are fortified with vitamin D. A fortified food is one that has had nutrients added to it. Although some foods contain vitamin D, most of the vitamin is made in your skin when you are exposed to sunlight. Once vitamin D is produced in the skin or consumed in food, it requires chemical change in the liver and kidney to form its active hormone form. Active vitamin D functions as a hormone because it sends a message to the intestines to increase the absorption of calcium. If you don't get enough vitamin D, your body is deficient in the vitamin and will not be able to use the calcium from food to build strong bones and teeth.

In space, astronauts may lose 20% of the calcium in their bones on long-duration space flights. Because the shuttle and the International Space Station are shielded to prevent crewmembers from being exposed to the Sun's rays, the crewmembers must consume vitamin D during space flight and eat foods that replace the lost calcium.

Procedure

1. For one day, keep a log of all the foods you eat and their portion sizes. Be sure to also include drinks in your log.
2. Use the Calcium Calculator Worksheet to identify any calcium-rich foods noted in your log.
3. Estimate the number of portions you ate for each food.
4. Total the number of portions in each category.
5. Multiply this number by the milligrams of calcium per serving.
6. Enter this amount in the box in the far right column.
7. Total the amounts in the boxes.
8. Record your calcium intake and your recommended daily allowance of calcium.
9. Compare your calcium intake to your calcium need.

Discussion

1. Why is calcium important to the body?
2. What are some common calcium-rich foods?
3. What role does vitamin D play in healthy bone development?
4. From what two sources do we get vitamin D?
5. What can you do to add more calcium to your diet?

Counting the Calcium*

Extensions

1. In this activity the amount of calcium in each food is an estimate, rounded for easy calculation. To find a more exact estimate of your calcium intake, conduct an Internet search for an online calcium calculator. Many dairy council sites include kid friendly calculators.
2. Design a series of daily menus that feature calcium-rich foods. Be sure to include some healthy calcium-rich snacks.
3. Launch a public service campaign to help make people aware of the need for calcium. You might write a commercial for your school announcements or make posters to hang in the school cafeteria. Contact your public broadcasting station or local radio station to see if they will allow you to put your announcement on the air.

*** This hands-on activity was adapted from activities in *From Outer Space to Inner Space/Muscles and Bones: Activities Guide for Teachers* created by Baylor College of Medicine for the National Space Biomedical Research Institute under NASA Cooperative Agreement NCC 9-58. The activities are used with permission of Baylor. All rights reserved.For additional activities visit http://www.nsbri.org/Education/Elem_Act.html**

Counting the Calcium*

CALCIUM CALCULATOR WORKSHEET

Check your food log and identify any calcium rich foods you ate from the Daily Calcium Needs table. Estimate the number of portions for each food you checked in the table. Total the number of portions and multiply by the milligrams of calcium per serving.
Put the total in the box at the far right and then add the amounts in these boxes. This final total is your estimated calcium intake.

Daily Calcium Needs

Age:				
	1–3 years	500 mg	4–8 years	800 mg
	9–18 years	1300 mg	19–50 years	1000 mg *
	51 + years	1200 mg		

NOTE: *The Recommended Daily Allowance is based on the amount of calcium needed for this age group. If you are younger or older, you may need to revise the amount of calcium in your diet.*

Calcium-rich Foods	Portion Size	# of portions yesterday	mg of Calcium per portion		Total mg of Calcium
____ Bagel	1	_____			
____ Bread	2 slices	_____			
____ Broccoli, cooked	¾ cup	_____			
____ Beans (Kidney, Lima)	1 cup	_____			
____ Corn tortilla	1	_____			
____ Kale, cooked	½ cup	_____			
____ Lentils	1 cup	_____			
____ Orange (fruit, not juice)	1 med.	_____			
	Total	_____	**x 50 mg**	=	**mg**
____ Bok choy	½ cup	_____			
____ Chickpeas	1 cup	_____			
____ Cottage cheese	½ cup	_____			
____ Ice Cream	½ cup	_____			
____ Parmesan cheese	1 Tbsp	_____			
____ Almonds	¼ cup	_____			
____ Eggs	2 whole	_____			
	Total	_____	**x 75 mg**	=	**mg**
____ Baked beans	1 cup	_____			
____ Cheese pizza	1 slice	_____			
____ Ice milk, Frozen yogurt	½ cup	_____			
____ Pancakes, Waffles *(made with milk)*	3 med.	_____			
____ Pudding *(with milk)*	½ cup	_____			
____ Soft and semi-soft cheeses *(such as mozzarella)*	1 ¼" cube	_____			
____ Soup made with milk	1 cup	_____			
____ Calcium enriched Cereal	1 cup	_____			
	Total	_____	**x 150 mg**	=	**mg**
____ American cheese	2 slices	_____			
____ Firm cheeses (such as cheddar, Swiss)	1 ¼" cube	_____			
____ Processed cheese	2 slices	_____			
____ Salmon, canned with bones	½ can	_____			
____ Sardines, canned with bones	½ can	_____			
____ Yogurt, fruit flavored	¾ cup	_____			
____ Macaroni and cheese	1 cup	_____			
	Total	_____	**x 250 mg**	=	**mg**
____ Milk, skim, 1%, 2% Whole, buttermilk, or chocolate	1 cup	_____			
____ Calcium-fortified beverages, e.g., soy, rice milk	1 cup	_____			
____ Orange juice with added calcium	1 cup	_____			
____ Ricotta cheese	½ cup	_____			
____ Skim milk powder	1/3 cup	_____			
____ Tofu	½ cup	_____			
____ Yogurt, plain	3.4 cup	_____			
	Total	_____	**x 300 mg**	=	**mg**

My calcium intake _____
My recommended intake _____
The difference _____

Oh, Say Can You C?

Segment 2

Purpose

To determine which fruits contain the largest amounts of vitamin C

Materials

3 different fruits (avoid red or purple fruits)
eyedropper
white construction paper
3 small cups or bowls
Vitamin C Data Chart (p. 53)
safety goggles
gloves
pen or marker
graph paper
colored pencils
materials prepared by the teacher

Background

Vitamins are important nutrients the body needs for healthy growth and development. They are removed from the foods we eat during a process called digestion. Different foods contain different vitamins, so a balanced diet with a variety of different foods is the key to good nutrition.

There are two types of vitamins: fat-soluble and water-soluble. Fat-soluble vitamins are vitamins that are stored in the fat tissues in the body and in the liver, where they remain until the body needs to use them. Some fat-soluble vitamins are stored for as little as a few days, while others can be stored for as long as six months. These vitamins should only be consumed in moderation. Exceeding the daily-recommended value of fat-soluble vitamins can be harmful to your health. Vitamins A, D, E, and K are all fat-soluble vitamins. Water-soluble vitamins are not stored in the body, but travel through the bloodstream. Whatever the body does not need passes out of the body in urine.

Vitamin C, also known as ascorbic acid, is a water-soluble vitamin that must be replaced often. Vitamin C is needed for growth and repair of body tissues and to help the body heal from injuries and infections. Vitamin C deficiency, caused by not eating enough foods containing vitamin C, may result in joint stiffness, nose bleeds, dry hair and skin, gingivitis (swelling of the gums), and extreme physical weakness. Vitamin C is an anti-oxidant as well. Antioxidants are nutrients that help prevent damage caused by oxidation. Oxidation is a chemical reaction that damages cell structure. Oxidation in our bodies can cause health problems such as cancer or heart disease. Natural foods that are very colorful are usually good sources of antioxidants. Green vegetables and citrus fruits are good sources of vitamin C.

The presence of vitamin C in foods can be detected using a cornstarch-iodine solution. When a liquid containing vitamin C is added to the solution, a color change occurs. This process is known as titration. The fewer drops required to change the color of the solution, the greater the amount of vitamin C.

*Note: Iodine may stain when it comes into contact with the skin. There may be some reactions associated with iodine. Please refer to a Material Safety Data Sheet (MSDS) that can be found online at sites such as: http://www.delasco.com/pcat/pdf/starchio.pdf

Teacher Prep

Cornstarch-iodine solution: 500 mL container; cornstarch; water; tincture of iodine; spoon; coffee filters; small, clear glass containers (three for each group or student); and eyedropper

CAUTION: An adult must prepare this solution.

1. Fill the 500-mL container with water.
2. Mix 30 mL (2 tablespoons (tbsp) of cornstarch into the water.
3. Stir thoroughly.
4. Filter the starch solution through several coffee filters until the solution is clear.
5. Using an eyedropper, add the tincture of iodine by drops, stirring constantly with the spoon. Keep adding drops until the solution turns a deep, dark blue. (If the solution turns brown, you have added too much iodine.)
6. Pour 10 mL of this solution into each clear glass container.

Oh, Say Can You C?

Segment 2

Procedure

1. Put on safety goggles and gloves.
2. Observe the three glass containers with the cornstarch-iodine solution and record your observations in your science journal.
3. Squeeze one fruit in a small cup or bowl so that it produces juice.
4. Hold a piece of white construction paper behind one container of the cornstarch-iodine solution.
5. Using an eyedropper, put the juice squeezed from the fruit into the solution, one drop at a time. Count each drop of juice as you add it. See diagram 1.
6. Carefully swirl the liquid in the container after each drop.
7. Continue adding the juice until the solution appears colorless against the white background paper.

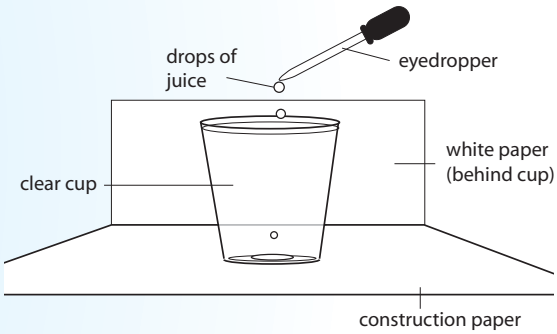


Diagram 1

8. Record the number of drops of juice you added to the cornstarch-iodine solution on the Vitamin C Data Chart.
9. Empty the container and rinse.
10. Using a different type of fruit, repeat steps 3–9.
11. Repeat steps 3–9 with the last fruit sample.
12. Create a graph to show the various levels of vitamin C in the different types of juice tested based on the number of drops you used for each.

Discussion

1. What is the relationship between the number of drops needed to turn the solution colorless and vitamin C?
2. Which type of juice had the most vitamin C? The least? How do you know?
3. Why is vitamin C important to our bodies?
4. What is the difference between water-soluble and fat-soluble vitamins?
5. Why must we replace vitamin C daily?

Extension

1. Research to find out the recommended daily value of vitamin C you should have in your diet. Plan a menu for one day that would allow you to get the recommended daily value of vitamin C you need to stay healthy. Find out about other antioxidants. Be sure to include these foods in your menu plan as well.
2. Compose a song or write a poem about the importance of vitamins and antioxidants. Share your song or poem with the class.
3. Obtain a vitamin C tablet or lozenge. Using the fact label, record the number of milligrams of vitamin C in the tablet. Dissolve the vitamin C tablet in 30 mL of water. Test the liquid by using the cornstarch-iodine solution. Using your results as a control, determine a way to estimate the amount of vitamin C found in the fruit juices you tested. Compare your findings with the nutrition labels on the package.

VITAMIN C DATA CHART

Type of Juice	Number of Drops of Juice Added to the Indicator Solution

Rate That Snack

Segment 2

Purpose

To identify the function of vitamins and minerals to a healthy body

To plan a nutritionally balanced snack

To design a realistic nutrition label for a snack food

Materials

Snack Questionnaire (p. 56)
snack food items
art paper (various colors)
pen or pencil
science journal
computer with Internet access
library access

Background

Vitamins are small molecules that the body needs to function properly. The body requires various vitamins. Children's bodies rely on the foods they eat to provide these vitamins, which are necessary for growth and development. Each vitamin has a different function in the body.

Minerals are also important to maintain a healthy body. Minerals, like vitamins, help the body grow, develop, and stay healthy. Minerals fall into two categories: macrominerals and trace elements, or microminerals. Macrominerals are minerals that the body needs in large amounts (100 mg/day or more). Trace elements are minerals that the body needs in small amounts to stay healthy.

Many people understand the importance of eating healthy meals for breakfast, lunch, and dinner, but they often forget to plan healthy snacks between meals. Snacks are especially important for growing children. Due to their smaller stomachs, children cannot take in enough food to provide adequate daily nutrition in just three meals. Snacks between meals can help satisfy a child's daily nutrition requirements when healthy foods are chosen.

Snacks should be planned as part of the day's food plan and eaten at regular times during the day. Also, snacks should only be eaten when you are hungry, not because you are bored or upset. Healthy snacks such as raw vegetables, fresh fruit, low-fat yogurt, low-fat cheese with whole-grain crackers, popcorn, and nuts are healthy alternatives to less nutritious snacks such as cookies and candy bars. If less nutritious foods are used for snacks frequently, they can adversely affect your health. It is very important to make healthy snack choices to keep your body healthy.

For most foods, nutrition facts can be found on the nutrition label on the outside of the food package. Labels include information about serving size, calories, fat, cholesterol, and percentage of daily values for certain nutrients, including vitamins and minerals. Recommended daily values (DV) are the amounts experts have decided are necessary to maintain good health. Because these daily values are based on a 2000 calorie diet, your diet values may be higher or lower depending on your personal calorie needs.

Packaging of certain foods can be deceiving. Just because the packaging on your snack food is fun and interesting does not mean that the food is necessarily a healthy choice. Likewise, packaging that appears dull and boring does not mean that food will not taste good. Do not judge a food by its packaging. Read the nutrition label so you can evaluate how healthy the snack food really is and be able to make wise food choices.

Teacher Prep

Request that students bring a sample of one or two snacks that they eat most often.

Procedure

1. Conduct research on the Internet or at the library to learn more about the vitamins and minerals your body needs.
2. Create a chart to show the most important vitamins and minerals and the recommended daily allowance for each.
3. Include a column to list the main purpose of that vitamin or mineral.
4. Using the Snack Questionnaire, keep a log of all snack foods you eat in a week.

Rate That Snack

Segment 2

5. Examine the food labels for each snack. Note: If you made the snack, you may need to do some research to learn about its ingredients.
6. Use the key on the questionnaire to rate each snack by using a number from 1 to 4, with 4 being a very healthy snack.
7. Have a partner become your "expert nutritionist."
8. The expert nutritionist should evaluate your snacking habits and give you advice on how to improve your snack choices to help keep your body healthy.
9. Make a list of the reasons you snack. If you snack for reasons other than hunger, brainstorm with your nutrition expert for ways to find other activities to do instead of snacking.
10. Work with your nutrition expert to create a healthy snack.
11. In your science journal, describe the snack and list all ingredients.
12. Conduct research to find the nutritional content of the ingredients in your snack.
13. Make a nutrition label for your snack. Be sure to identify the vitamins and minerals that the snack contains and list the fats and sugar content.
14. Using art paper, create the packaging and nutrition label for your snack item.
15. Remember to make the packaging fun and interesting enough to grab the shoppers' attention.
16. Share your new idea of a snack food with your class and explain why it is nutritious, or healthy, and why they should eat it.

Discussion

1. Why are vitamins and minerals important to the body?
2. What kinds of foods could you eat to add more vitamins and minerals to your diet?
3. If you are eating healthy meals, why is it important to eat healthy snacks?
4. What unhealthy snack habits might you need to change?
5. Make a list of healthy snacks for you and your family.

Extension

Using the library and Internet, research the various vitamins and minerals your body needs. Create an A to Z book to show the necessary vitamins and minerals your body needs. Be sure to include why each vitamin and mineral is important and what foods are the best sources for each.

Refried Beans
Fat Free

Nutrition Facts

Serving Size 1/2 cup (125g)
Serving Per Container 3.5

Amount Per Serving	
Calories 130	Calories from Fat 0
	% Daily Value*
Total Fat 0g	**0%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 490mg	**20%**
Total Carbohydrate 24g	**8%**
Dietary Fiber 7g	**28%**
Sugars 0g	
Protein 9g	**16%**
Vitamin A	**0%**
Vitamin C	**0%**
Calcium	**6%**
Iron	**15%**

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

SAMPLE NUTRITION LABEL

Rate That Snack

Snack Questionnaire

Snack Food	Where You Ate It	Why You Ate It	Vitamins and Minerals	Sugar Content	Calcium Content	Fat Content	Snack Rating *

Snack ratings:

4 – a very healthy snack; low in sugar; low in fat; high in one or more vitamins or minerals

3 – a healthy snack; low to medium in sugar, but high in vitamins or minerals

2 – a somewhat healthy snack; low in sugar, but may be high in fat; has only small amounts of recommended vitamins or minerals

1 – unhealthy snack; high in sugar and fat; has little nutritional value

Answer Key

Segment 2

Putting on the Bone

1. The clay person without bones will fall over and bend in half. It is unable to stand upright or maintain its shape. The clay person with bones will be able to stand upright on its own, maintaining its shape.
2. The skeleton gives the body support, shape, and protection but is also light enough to make movement easy.
3. The cup filled with the beans held the most weight. Answers will vary, but students should understand that a mostly solid cylinder is able to hold more weight than a hollow cylinder.
4. The cup filled with the beans is most like our bones. The cup represents the hard outer walls. The beans are similar to the hard, spongy layer filled with tiny holes found inside our bones.
5. Although the outside structure of the bone is similar to our bones, the inside of the chicken bones (and other bird bones) is hollow, making the bird lighter. This configuration is an important adaptation to allow flight.

Hole-y Bones

1. Calcium is important to build and maintain strong bones and teeth.
2. As bone mass is lost, the bones weaken and become fragile, making fractures more likely.
3. Answers will vary by age: the adult recommended daily allowance (RDA) is 1200 mg; children's RDA is 800 mg.
4. To prevent bone mass loss, you should get the recommended daily amount of calcium, preferably by eating calcium-rich foods and by being physically active to help strengthen bones.

Bendy Bones

1. The bone left in the water (the control bone) was the strongest. The bone that had been soaking in the vinegar for the longest amount of time was the weakest. You could determine the strength of the bone by whether or not the bone would bend.
2. Vinegar, an acid, slowly dissolves the calcium in the bones, making them weak.
3. The bone weakens and becomes flexible. The bones left in the vinegar continued to get weaker so the angle at which you could bend them increased.
4. Long-term effects of calcium loss can include an increased chance of broken bones, unhealthy teeth and gums, and rickets.

Counting the Calcium

1. Calcium is necessary to build strong bones and teeth, regulate the heartbeat, clot the blood, maintain proper thyroid function, and help transmit nerve impulses.
2. Some common calcium-rich foods include broccoli, beans, and dairy products, such as milk, cheese, and yogurt.
3. Vitamin D helps the body absorb the calcium that is consumed.
4. We can get vitamin D from fortified foods, but most of it is made in our skin when we are exposed to sunlight.
5. Eating calcium-rich foods is the best way to add calcium to our diets.

Oh, Say Can You C?

1. The fewer drops needed to turn the solution colorless, the greater the amount of vitamin C.
2. Answers will vary depending on type of juice tested. The juice that required the least number of drops of the iodine solution to turn the solution colorless will contain the most vitamin C.
3. Vitamin C is needed to keep body tissues in good shape and to help the body heal from injuries and infections.
4. Water soluble vitamins are not stored in the body and must be replaced often, whereas fat-soluble vitamins are stored for as long as six months in the fat tissues of the body until they are needed. .
5. Vitamin C is water-soluable and is depleted throughout the day. Therefore it must be replaced daily.

Rate That Snack

1. Vitamins and minerals help the body grow, develop, and stay healthy.
2. Answers will vary, but should include fruits, vegetables, and low sugar snacks.
3. Most common snack foods are high in fats, sugar, and sodium and may replace nutritious snacks that are better for a healthy body.
4. Answers will vary, but students should identify unhealthy snacks.
5. Answers will vary, but healthy lists should include such snacks as raw vegetables, fresh fruit, low fat–yogurt, popcorn, or nuts.

On the Web

Being on the Inside

1. The paper towel with the most folds absorbs the most water because the folds give the towel more surface area that comes in direct contact with the water.
2. The inner surface of the small intestine is ridged, not smooth, giving the inside of the tube more surface area to absorb large quantities of liquid nutrients.
3. If the lining of the small intestine were smooth, many of the liquid nutrients would not be absorbed and would simply pass through the digestive system, unusable by the body.
4. The water in cup A is yellow-orange because the iodine has been added.
5. The water in cup B turned blue-black because iodine changes color in the presence of starch.
6. The water inside the plastic bag also turned blue-black after about 30 minutes because the iodine molecules are small enough to pass through the plastic bag and react with the starch inside.
7. During digestion, the vitamins and minerals from food break down into liquid nutrients and are then absorbed through the lining of the small intestine. The cell membranes allow some nutrients to pass through, but they prevent waste from entering the cell. The folds in the paper towel are similar to the lining of the small intestine. The folds provide more surface area, allowing the body to absorb more of the liquid nutrients. These nutrients then pass through the cell membrane like the iodine solution passed through the plastic bag.

The NASA SCI Files™

The Case of the Physical Fitness Challenge

Segment 3

While jogging at Sandy Bottom Nature Park in Hampton, Virginia, the detectives remember that the U.S. Surgeon General, Vice Admiral Carmona, had suggested that they need to learn more about the new food guide pyramid. They email Tony, who heads over to Texas A&M University in College Station, Texas to visit Dr. Joanne Lupton, Regents Professor and Program Leader for the National Space Biomedical Research Institute (NSBRI). Dr. Lupton also worked with the Food and Drug Administration (FDA) to help create new dietary guidelines, and she explains the new food guide pyramid categories and how to determine the correct number of portions in each group for an individual. Dr. Lupton recommends that they speak with Dr. Ted Mitchell of the Cooper Clinic in Dallas, Texas and a member of the Science Board for the President's Council on Physical Fitness and Sports. Bianca and Blake dial up Dr. Mitchell to learn about a person's basal metabolic rate (BMR) and why it is important to calculate BMR. Bianca and Blake also get some help from a NASA SCI Files™ Kids' Club member, Callum Mackie, who visits Ms. Gill Poulter at the Discovery Point Antarctic Museum in Dundee, Scotland. Ms. Poulter explains the importance of nutrition in exploration and tells them that when the RRS *Discovery* made the first exploration expedition to Antarctica, nutrition was a concern but little was known about it.

Objectives

Students will

- interpret the new food guide pyramid.
- test foods for complex carbohydrates.
- compare estimated portion sizes to the recommended portion size.
- determine the importance of portion size to a healthy diet.
- determine which kinds of foods contain protein.
- discover which foods contain fat.
- design menus for special needs by using the new food guide pyramid.

Vocabulary

Basal Metabolic Rate (BMR) – an estimate of a person's energy needs at rest

Body Mass Index (BMI) – a formula to estimate how much body fat a person has based on height and age

discretionary calories – the small number of calories you can use on luxury foods, such as fats or added sugars, after choosing foods with the essential nutrients your body needs

nutrition – the study of food components (called nutrients) as they are eaten, used by the body, and removed from the body

scurvy – disease caused by lack of vitamin C

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Before viewing Segment 3 of *The Case of the Physical Fitness Challenge*, discuss the previous segment to review the problem and assess what the tree house detectives have learned thus far. Download a copy of the **Problem Board** from the NASA SCI Files™ web site, select **Educators**, and click on **Tools**. The **Problem Board** is also in the **Problem-Solving Tools** section of the latest online investigation. Have students use this section of the web site to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 2 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have occurred during previous segments. Use tools located on the Web, as was previously mentioned in Segment 1.
4. Review the list of ideas and additional questions that were created after viewing Segment 2.
5. Read the overview for Segment 3 and have students add any questions to their list that will help them better understand the problem.
6. **Focus Questions**—Print the questions from the **Educators** area of the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the program so they will be able to answer the questions. An icon will appear when the answer is near.
7. **"What's Up?" Questions**—These questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. You can print them from the **Educators** area of the web site ahead of time for students to copy into their science journals.

View Segment 3 of the Video

For optimal educational benefit, view *The Case of the Physical Fitness Challenge*© in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" Questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Have students work in small groups or as a class to discuss and list what new information they have learned about bones, muscles, and the importance of calcium to the body. Organize the information, place it on the Problem Board, and determine whether any of the students' questions from the previous segments were answered.
4. Decide what additional information the tree house detectives need to determine how to become physically fit. Have students conduct independent research or provide students with information as needed. Visit the NASA SCI Files™ web site for an additional list of resources for both students and educators.
5. Choose activities from the **Educator Guide** and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.
6. For related activities from previous programs, download the appropriate **Educator Guide**. On the NASA SCI Files™ home page, select the fence post that says "**Guides**." Click on the **2002–2003 Season** tab and then click on The *Case of the Biological Biosphere*©. In the green box, click on **Download the Educator Guide**.

   a. In the **Educator Guide** you will find

      a. Segment 3 – *You Are What You Eat*, page 43

   Click on the **2004–2005 Season** tab and then click on *The Case of the Great Space Exploration*©. In the green box, click on **Download the Educator Guide**.

   b. In the **Educator Guide** you will find

      a. Segment 2 – *Eating Healthy in Space*, page 41

      b. Segment 2 – *Basal Metabolic Rate and Calories*, page 37

   To locate additional activities and worksheets on the Web, click on **Activities/Worksheets** in the tool bar located at the top of the window. Scroll to the **2004–2005 Season** and click on *The Case of the Great Space Exploration*©. In the **Activities/Worksheet** section, you will find

   c. Sources of Energy (calories)

   Scroll to the **2002–2003 Season** and click on *The Case of the Biological Biosphere*©. In the **Activities/Worksheet** section, you will find

   d. *Where Are the Nutrients?*
7. If time did not permit you to begin the web activity at the conclusion of Segments 1 or 2, refer to number 6 under **After Viewing** on page 15 and begin the PBL activity on the NASA SCI Files™ web site. If the web activity was begun, monitor students as they research within their selected roles, review criteria as needed, and encourage the use of the following portions of the online, PBL activity:
   - **Research Rack**—books, internet sites, and research tools
   - **Problem-Solving Tools**—tools and strategies to help guide the problem-solving process.
   - **Dr. D's Lab**—interactive activities and simulations
   - **Media Zone**—interviews with experts from this segment
   - **Expert's Corner**—listing of Ask-an-Expert sites and biographies of experts featured in the broadcast
8. Have students write in their journals what they have learned from this segment and from their own experimentation and research. If needed, give students specific questions to reflect upon, as suggested on the PBL Facilitator Prompting Questions instructional tool found by selecting **Educators** on the web site.
9. Continue to assess the students' learning, as appropriate, by using their journal writings, problem logs, scientific investigation logs, and other tools found on the web site. Visit the **Research Rack** in the Tree House and find the online PBL investigation main menu section, **Problem-Solving Tools**, and the **Tools** section of the **Educators** area for more assessment ideas and tools.

Careers

farmer
horticulturist
nutrition advisor
nutritional biochemist
nutritionist
registered dietician

Resources *(additional resources located on web site)*

Books

Barron, Rex: *Showdown at the Food Pyramid.* Penguin Putnam Books for Young Readers, 2004 ISBN: 0399237151.

Beery, Barbara: *Batter Up Kids Sensational Snacks*. Gibbs Smith, 2005, ISBN: 1586857983.

Bledsoe, Lucy: *The Antarctic Scoop*. Holiday House, Inc., 2003, ISBN: 0823417921.

Cowcher, Helen: *Antarctica*. Farrar, Straus, and Giroux, 1991, ISBN: 0374403716.

DK Publishing: *DK Children's Cookbook*. DK Publishing, 2004, ISBN: 0756605970.

Grosset and Dunlap: *The Wiggles Eat Right*. Penguin Putnam Books for Young Readers, 2005, ISBN: 0448437368.

Hooper, Meredith: *DK Readers: Antarctic Adventure, Exploring the Frozen Continent*. DK Publishing, 2000, ISBN: 0789466848.

Kalman, Bobbie: *Lunch Munch*. Crabtree Publishing Company, 2003, ISBN: 0778712737.

Leedy, Loreen: *The Edible Pyramid.* Holiday House, Inc., 1997, ISBN: 0823412334.

Rockwell, Lizzy: *Good Enough to Eat: A Kid's Guide to Food and Nutrition.* HarperCollins Publishers, 1999, ISBN: 0060274344.

Sears, William and Sears, Martha: *Eat Healthy, Feel Great.* Little, Brown, and Company, 2002, ISBN: 0316787086.

White, Andrea: *Surviving Antarctica: Reality TV 2083.* HarperCollins Publishers, 2005, ISBN: 0060554541.

Video

Cerebellum: *The Standard Deviants Learn Nutrition* (2004)
Grades 5–12

Discovery School: *Food Pyramid* (2004)
Grades 3–6

Disney: *Bill Nye the Science Guy: Nutritio*n (1996)
Grades 3–6

National Dairy Council: *Moo 2 You* (1999)
K–5

Schlessinger Media: *All about Nutrition and Exercise* (2001)
Grades K–4

Schlessinger Media: *Nutrition* (2005)
Grades K–4

Yum Yum Studios: *Food Safari: Lunch* (2003)
Grades K–4

Web Sites

NASA KSNN™ (Kids' Science News Network™)
Find the answers to questions like, "Why do astronauts eat tortillas instead of bread?" or "Are there grocery stores in space?" This site includes 60-second animations, activities, and resource links.
http://ksnn.larc.nasa.gov/exploration.html

Texas A&M University
The Texas A&M University System is one of the largest, most complex systems of higher education in the nation. Through a statewide network of nine universities, seven state agencies and, a comprehensive health science center, the A&M System educates nearly 100,000 students, conducts more than $500 million in research, and reaches another 11 million people through service each year.
http://tamusystem.tamu.edu/

United States Department of Agriculture
This is the official web site of the new food pyramid. Learn all about the new nutrition guidelines that will help you lead a healthy life.
http://www.mypyramid.gov/

*Note: If you visit www.mypyramid.org, be aware that this site is not affiliated with the official USDA web site.

Dole 5 A Day
This site is packed with fun activities, all designed to motivate people to be physically active and to eat more fruits and vegetables.
http://www.dole5aday.com/

Department of Health and Human Services
Visit this Center for Disease Control and Prevention web site to learn more about your favorite fruits and vegetables.
http://www.cdc.gov/nccdphp/dnpa/5aday/month/index.htm

Southeastern Michigan Dietetic Association
Visit this web site to see sample food pyramids for cultural foods, such as Italian, Indian, and Mexican. Plan a healthy, well-balanced ethnic meal.
http://semda.org/info/#pyramid

Cooper Aerobics Center
The Cooper Aerobics Center is a multidivisional health and fitness complex in Dallas, Texas.
http://www.cooperaerobics.com/default.aspx

Discovery Point Antarctic Museum, Dundee, Scotland
Visit this site to learn about the Royal Research Ship (RRS) *Discovery*. Explore the ship, view a time line of important events, and learn all about the history of this special ship and its crew.
http://www.rrsdiscovery.com/

Activities and Worksheets

What's New in the Food Guide Pyramid?

Segment 3

Purpose

To interpret the new food guide pyramid

Materials

Per Student
plastic bowl
sheet of legal size paper
science journal

Background

The new food guide pyramid was released in 2005. The pyramid symbol is simple and is meant to encourage consumers to make healthier food choices, to be active every day, and to make personal choices that fit their own needs. Physical activity, represented by the person walking up the side of the pyramid is a new element in the symbol. The steps on the side also represent the idea that individuals can benefit by taking small steps to improve their diets and lifestyles each day. The six color bands represent the food groups: orange is for grains; green is for vegetables; red is for fruits; blue is for milk or calcium rich foods; purple is for meats and beans (proteins); and the thin band of yellow is for fats and oils. The bands are wider at the bottom and get smaller toward the top to show us that moderation, or watching how much we eat from each group, and careful choices within each food group are important. The recommended daily amounts are given for a 2,000-calorie diet. To find the amounts that are right for you, go to http://www.MyPyramid.gov and investigate the new food guide pyramid.

Teacher Prep

1. In a large, open area, determine the playing field by using cones or other objects to mark boundaries.
2. Cut sheets of construction paper into rectangles (approximately 5 cm x 8 cm). Use the chart to determine the number of cards needed for each color. Label the different colored rectangles as follows:

Color	Label	Number of Students			
		5–9	10–15	15–20	20–25
Orange:	G-1oz.	36	60	90	120
Green:	V-$^1/_2$ cup	30	50	75	100
Red:	F-$^1/_2$ cup	24	40	60	80
Blue:	M-$^1/_2$ cup	36	60	90	120
Purple:	MB-1 oz.	36	60	90	120

Note: *You may wish to laminate the cards so they will last longer.*

3. Spread the cards over the large open area designated for play.

Procedure

1. Position your bowl at the edge of the designated playing field.
2. The bowl marks your home base.
3. The colored cards scattered over the field represent the five main food groups on the new food guide pyramid:

   Grains – orange

   Vegetables – Green

   Fruits – Red

   Milk – Blue

   Meats and Beans – Purple

What's New in the Food Guide Pyramid?

4. Use the following rules to begin collecting food cards when signaled:
   a. Collect one card at a time.
   b. Put the card in your bowl before you collect another card.
   c. Walk, don't run as you gather your food cards.
   d. Try to get as many different colors as possible.
5. When all cards have been gathered, return to your classroom.
6. Divide a sheet of legal size paper into six columns.
7. Label each column the same as a column on the food guide pyramid: grains, vegetables, fruits, milk, and meats and beans.
8. Organize your food cards into the correct columns.
9. Pretend the cards you gathered are the foods you ate in one day.
10. Add up the number of servings you have in each column. For example, if you have four green cards and each card represents $^1/_2$ cup, you have eaten two cups of vegetables for the day.
11. Compare your numbers with the USDA recommended amounts for each category.
12. Determine whether you had a well balanced diet.
13. Visually represent the amount of food in each category that you gathered compared to the amount of food recommended by the USDA. A picture graph or a histogram might be helpful.
14. In your science journal, explain how to make your diet more well-balanced.
15. Make a list of foods to fit into each category.

Discussion

1. What is the USDA recommended amount of vegetables each day?
2. Why are milk products important to your diet?
3. What types of foods does the USDA consider grains?
4. How do you get protein into your diet?
5. Why do you think the USDA suggests that you "go easy on fruit juices?"
6. What does the new food guide pyramid mean to you?

Extensions

1. Play the game by using yellow cards to represent fats. Each time a yellow card is collected, you must run around the outside of the playing field one time before you can collect another card.
2. Add situation cards to the game. Situations might include the following:
   • You played a hard game of basketball today. You need one additional serving of meats and beans.
   • You did not go outside to play today so your body could not absorb any vitamin D, which helps process calcium. Lose one of your milk servings.
3. Visit MyPyramid.gov to find out more about the new food guide pyramid. Learn about discretionary calories. Get some tips for adding more whole grains to your diet.
4. Find out how many calories you burn doing common activities. Write a poem or make a poster about what you learned. Share it with your class.

Black and Blue

Segment 3

Purpose

To test food for complex carbohydrates

Materials

(per group)
bread slice
crackers
potato slice
rice
cornstarch
white granulated sugar
apple slice
paper plates
eyedropper
science journal
pen or pencil
gloves
safety goggles
500-mL measuring cup with iodine solution

Background

Carbohydrates are large groups of compounds that include sugars and starches. These compounds are made naturally by plants. Carbohydrates are the major source of energy for the body. Most foods contain carbohydrates. There are two major types of carbohydrates—simple and complex. Both simple and complex carbohydrates are necessary for a healthy body.

Simple carbohydrates are also called simple sugars. Simple sugars are found in fruits, milk, and foods with refined sugars, such as sugary snacks. Simple sugars from fruits and milk are healthier because these foods contain vitamins, fiber, and other nutrients. Refined sugars should be limited because they contribute calories with very few nutrients.

Complex carbohydrates are also called starches. Starches include grain products such as bread, crackers, pasta, and rice. Some complex carbohydrates are healthier than others. Refined grains are grains that have been processed, removing nutrients and fiber from the grains. White flour and white rice are examples of refined grains. Most refined grains are "enriched," which means certain vitamins and iron, but not the fiber, are put back in after processing. Unrefined grains, or whole grains, contain vitamins, minerals, protein, and fiber. Fiber is very important for the digestive system and heart health.

The United States Department of Agriculture (USDA) offers tips to help put more whole grains in your diet. Visit the USDA web site at www.mypyramid.gov for information about eating a well-balanced healthy diet.

You can use an iodine solution to detect the presence of complex carbohydrates. The yellow-orange iodine will turn blue-black as it reacts with starch. (The iodine solution will show no reaction with simple carbohydrates or sugars.)

***Note:** *Iodine may stain when it comes into contact with the skin. There may be some reactions associated with iodine. Please refer to a Material Safety Data Sheet (MSDS), which you can find online at sites such as http://www.delasco.com/pcat/pdf/starchio.pdf.*

Teacher Prep

Cut the potatoes and apples into thin slices. Prepare an iodine solution for each group as follows:

1. Fill the measuring cup _ full of water.
2. Add 20 drops of iodine to the water in the cup and stir. Note: Straws or pipettes may be substituted for eyedroppers. See diagram 1.

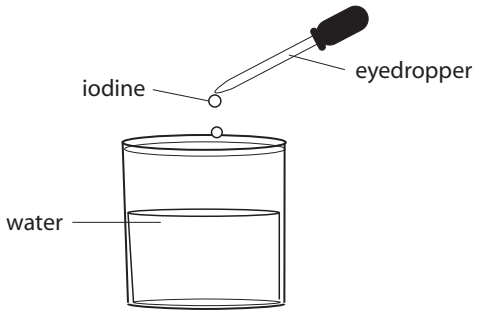


Diagram 1

Procedure

1. Put on gloves and safety goggles.
2. Place a small amount of cornstarch on a paper plate.
3. Using the eyedropper, apply a few drops of the iodine solution onto the cornstarch.
4. Observe the color of the iodine on the cornstarch. Because cornstarch is a complex carbohydrate, this sample will be a control for comparison of other samples.
5. Choose a food sample to test and place it on a paper plate.

Black and Blue

6. Using the eyedropper, apply a few drops of the iodine onto the food sample.
7. Observe and note the color of the area where the iodine solution was applied. Foods that contain starch will turn blue-black when the iodine is added to them. See diagram 2.
8. Record your observations in your science journal.
9. Continue testing until all samples have been tested.

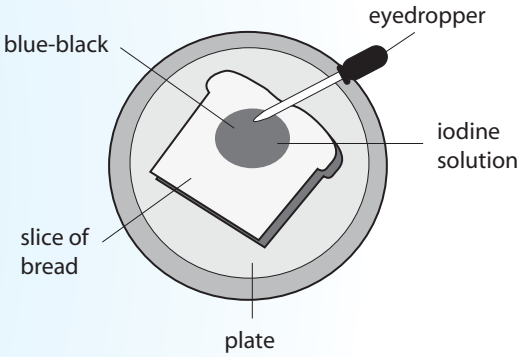


Diagram 2

Discussion

1. What are the two types of carbohydrates? Give examples of each.
2. Which samples contained complex carbohydrates? How could you tell?
3. Why is it important to add more whole grains to your diet?

Extension

1. Research to find out more about carbohydrates. Explain why athletes need more complex carbohydrates in their diets.
2. Test additional foods for complex carbohydrates.
3. Conduct research to find a test for simple sugars.
4. Plan a healthy diet that includes both simple and complex carbohydrates.

Portion to Portion*

Segment 3

Purpose

To compare estimates of portion size to the recommended portion size

To determine the importance of portion size to a healthy diet

Background

You can find food labels on nearly every type of food you buy. The nutrition facts on the food label are regulated by the Food and Drug Administration (FDA) to ensure accuracy. Some basic nutrition facts listed on a food label are serving size, calories, fat, cholesterol, sodium, carbohydrates, and protein. Serving size, or a portion, is very important to a healthy diet. Portion size gives the amount of food recommended to be eaten in a single sitting. Portion size can vary for different kinds of foods: solids versus liquids and raw versus cooked. Portion size helps people understand how much they are eating. For example, if a serving size listed on a nutritional label is 10 chips and you eat 20 chips, you just ate two portions of chips. To find the calories, fat, cholesterol, and other nutritional values for the chips, multiply each value listed on the label by two (the number of portions you ate). One package often contains multiple portions. You can use some common, quick-hand measures to help you estimate portions. For example, a closed fist is about the same size as a piece of fruit or a cup of raw vegetables. Understanding how to measure portion size is a key factor in maintaining a healthy diet.

The new food guide pyramid no longer uses the term serving size. It now promotes "portion size," which is measured by using standard household measurements. Visit http://www.mypyramid.gov for more information.

Teacher Materials

frozen peas (2 packages)
dry breakfast cereal
popped popcorn
3 large containers (for the dry foods above)
2-liter bottle of regular soft drink
8 measuring cups (any size)
4 pieces of paper or cardstock

Materials

Per Group
6 paper plates
2 large, plastic cups
marker
Labels and Estimates Handout
pen or pencil
science journal
Portion Size Worksheet (p. 71)
Serving Size Worksheet (p. 71)

Teacher Preparation

1. Place the food items and drink into the appropriate containers.
2. Remove the nutrition label from the food items and drink packaging.
3. Glue each nutrition label to 1/2 a piece of paper.
4. Fold the paper in half to hide the nutrition label from view.
5. Create four stations for students to rotate through by placing a container of each food item and drink at a different table.
6. Place a measuring cup (any size) at each station.
7. Place the folded paper with the nutrition label on the table so that it cannot be viewed.
8. Label the stations for easy identification by students.

Procedure

1. Using a marker, label three of the paper plates and one cup "estimate."
2. Label the remaining three paper plates and one cup "actual."
3. On the **Serving Size Worksheet**, write the names of the food items under Food Name on each table.
4. Go to the first station and estimate how many cups (or fractions of a cup) make up one portion size of that food item or drink.
5. Record your estimate on the **Portion Size Worksheet**.
6. Measure the estimated amount of the food item or drink and place it on the plate or in the cup labeled "estimate."

Portion to Portion*

7. Observe your estimated measurements and record.
8. Open the folded paper and read the "Nutrition Facts" label for the food item or drink.
9. Record the actual recommended serving size for each on the Serving Size worksheet.
10. Measure the actual recommended serving size and place it on the plate or in the cup.
11. Observe and compare your estimated portion size to the actual recommended serving size.
12. Record your observations in your science journal.
13. Rotate to the next station and repeat until you have visited all four stations.

Discussion

1. How did your estimated portion size compare to the actual portion suggested on the nutrition label?
2. Why do you think it is important to look at the serving size (portion size) on a label?

Extensions

1. Test your friends and family on their knowledge of portions. Prepare a similar activity for them by gathering various food items from your home and removing the nutrition labels. Have them estimate and compare their estimates to the recommended portion size.
2. Quick-hand measures are an easy way to help judge portion size. Look at some suggested hand measures below. How would you use them to help you determine portion size? Can you think of any other appropriate quick hand measures? Experiment to develop some quick hand measures of your own to help with portion size.

Use the Quick Hand Measures to estimate the size of one serving of different foods.

Quick Hand Measures

A closed fist = Piece of fruit or cup of raw vegetables	Two fingers = Ounce of cheese	A cupped hand = Cup of dry cereal	An open hand = Single serving of meat	Tip of thumb = Teaspoon of butter

* **This hands-on activity was adapted from activities in From Outer Space to Inner Space/Food and Fitness: Activities Guide for Teachers created by Baylor College of Medicine for the National Space Biomedical Research Institute under NASA Cooperative Agreement NCC 9-58. The activities are used with permission of Baylor. All rights reserved. For additional activities visit http://www.nsbri.org/Education/Elem_Act.html**

Portion to Portion*

Portion Size Worksheet

Food Name	1 Portion Estimate of Food – use cups as a measure

Serving Size Worksheet

Food Name	"Nutrition Facts" Food Label *(recommended serving size)* – use cups as a measure

A Little "Pro" Testing

Segment 3

Purpose

To determine which kinds of foods contain protein

Materials

piece of aluminum foil
feather
skewers
lighter
food samples (i.e.: cheese, sugar, apple, hot dog, potato, bread, peanut butter, gum drops)
water
container for water
science journal

Background

Proteins are compounds that are very important for almost all parts of the body. They are a source of calories, or food energy. Proteins build, maintain, and replace the tissues in your body. Your muscles, organs, and immune system are made up of mostly protein. Many foods, such as beef, poultry, fish, eggs, dairy products, nuts, seeds, and legumes (like beans) contain proteins. In the new food guide pyramid, proteins are contained in the "meat and beans section. Go to: www.mypryamid.gov.

There are two main types of protein—complete and incomplete. Complete proteins contain all nine essential amino acids. Amino acids are food that is broken down into basic units. These basic units can be reused to make the proteins your body needs. There are about 22 amino acids that are important to good health. The human body can make 13 of them, but the other nine (the essential amino acids) can only be obtained from protein-rich foods. Complete proteins come from animal sources, such as meat and milk. Incomplete proteins are considered incomplete because they lack one or more of the essential amino acids. Vegetables are sources of incomplete proteins.

A healthy diet has a balance of complete and incomplete proteins. The amount of protein needed for a well-balanced diet depends on age, gender, and physical activity. Most Americans get enough protein in their diet but need to make leaner (less fat) and more varied choices from this food group.

If you burn a food that contains protein, it will produce an unpleasant odor.

CAUTION NOTE: This activity should be done as a teacher demonstration only.

Procedure

1. Place the piece of aluminum foil on a flat surface.
2. Hold one end of the feather (the end without feathers) over the aluminum.
3. Using a lighter, carefully light the other end (with feathers).
4. Observe the smell of the burning feather. This smell is your standard when testing the other foods for protein.
5. Students should record their observations in their science journals.
6. Blow out the fire and soak the feather in water to be sure the fire is out.
7. Using a skewer, spear a food sample.
8. Hold the skewer over the aluminum foil and carefully light the food sample with the lighter.
9. Observe the smell of the burning food. Have students compare the smell of the burning food to the smell of the burning feather.
10. Have students record their observations in their science journals.
11. Blow out the fire and soak the food sample in water to be sure the fire is out.
12. Repeat steps 7–11 for the remaining food samples.

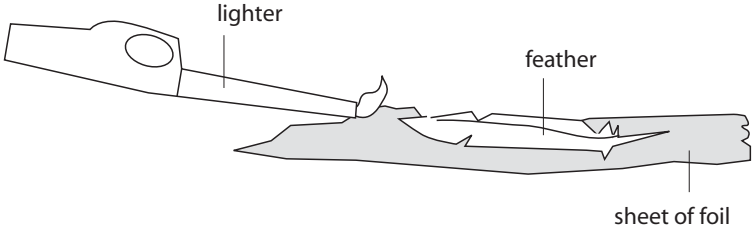


Diagram 1

A Little "Pro" Testing

Segment 3

Discussion

1. Which food contained protein? How did you know?
2. Why are proteins important to the body?
3. Explain the difference between a complete and an incomplete protein?

Extension

1. Another way to test for the presence of protein in foods is to use a solution of potassium or sodium hydroxide. Put the potassium solution into clear, glass jars. Add one food item to each jar. Add a few drops of diluted copper sulfate solution to each jar. If the food contains protein, the solution will turn pink or blue.
2. Using a computer with internet access, go to www.mypyramid.gov and click on the food guide pyramid. Go to the section about meats and beans. Check to see if the foods you identified as containing protein are on the list of protein foods. Find out how many servings of protein rich foods you should have each day.

Getting to the Fat of the Matter

Segment 3

Purpose

To determine which foods contain fat

Materials

various food samples
brown paper bags cut into small square pieces
baking sheet
science journal
pen

Background

Fats are oily substances found in some foods, such as nuts, oils, butter, and some meats. Other foods, such as most fruits and vegetables, do not have any fat. Fat is an essential component to a healthy diet. Fat helps the body grow and develop normally. Fats help give the body energy and the ability to absorb some vitamins. Little children especially need fats to help their brains and nervous systems develop properly.

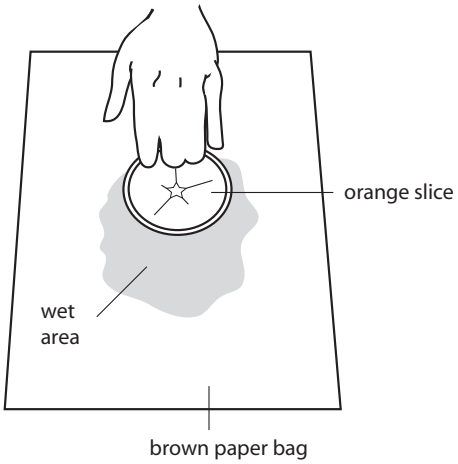
Although fats are a source of energy (calories), the body stores excess fat that may cause health problems. There are three types of fats: unsaturated fats, saturated fats, and trans fats. Unsaturated fats are found in foods that come from plants and fish. These fats tend to be beneficial to a healthy heart. Foods with unsaturated fats include olive oil, peanut oil, canola oil, tuna, and salmon. Saturated fats are fats found in animal products. Diets too high in saturated fats can raise blood cholesterol levels and increase the risk of heart disease. Some examples of foods with saturated fats are butter, cheese, beef, and milk (except skim milk). Trans fats are fats that can raise cholesterol and increase the risk of heart disease if eaten in large quantities. Trans fats are fats that are listed in the food ingredient list as hydrogenated or partially hydrogenated. Margarine is an example of a trans fat.

Fats, sugars, and salt (sodium) are represented on the new food guide pyramid with a small yellow band. The United States Department of Agriculture (USDA) recommends that we limit the amounts of fats, sugars, and salt we consume. The USDA also suggests that the majority of the fats in our diet should come from fish, nuts, and vegetable oils rather than from solid fats such as butter or margarine.

When fats are present in food, they leave a greasy streak behind on a piece of paper. When the paper is held up to the light after it has been heated, the light will shine through the paper.

Procedure

1. Choose a food sample and a square piece of brown paper bag.
2. Using a pen, write the name of the food on the paper bag.
3. Rub the food sample on the piece of paper bag and allow the paper to dry.
4. Hold the paper bag up to the light.
5. Observe and record your observations in your science journal.
6. Repeat steps 1–5 using the remaining food samples.
7. Place the paper bag squares onto a baking sheet and set it in direct sunlight.
8. Allow the baking sheet to sit in sunlight for approximately 15–20 minutes as you monitor the paper bags.
9. Check the paper bags for grease spots and record your observations.



Getting to the Fat of the Matter

Discussion

1. Which foods left a mark on the paper after they were dried? Which did not?
2. Why did some foods leave a mark on the paper while other foods did not?
3. Classify the food samples according to the food groups found on the new food guide pyramid. Which food groups had samples that tested positive for fats?
4. What color on the new food pyramid represents fats? Why is this band so small?

Extensions

1. Repeat the experiment with other types of foods from each part of the food guide pyramid. Is there a difference between the fat content of the different categories of the food guide pyramid?
2. Research how a diet too high in saturated fats can be harmful to your health. Create a poster to show the health risks associated with fats and ways to reduce the amount of saturated fat in your diet.

Answer Key

What's New in the Food Pyramid Guide?

1. The United States Department of Agriculture (USDA) recommends $2^1/_2$ cups of vegetables each day.
2. Milk products provide the necessary calcium you need each day.
3. Grains such as cereals, breads, crackers, rice, and pasta are considered grains. At least half the grains you eat each day should be whole grains.
4. Include proteins in the diet by eating lean meats, fish, peas, nuts, and beans.
5. Many fruit juices contain large amounts of sugar.
6. Answers will vary, but students should understand that the new pyramid is designed to meet the needs of each individual, that it includes food from each of the food groups, and that physical activity and personal choices are important parts.

Black and Blue

1. The two types of carbohydrates are simple carbohydrates (sugars) and complex carbohydrates (starches). Fruits contain simple sugars, and bread, crackers, or pasta contain starches.
2. Answers will vary depending on the foods tested, but bread, crackers, potatoes, and rice should be listed. If the iodine turned blue-black when placed on the sample, the food contains starch or complex carbohydrates.
3. Whole grains contain vitamins, minerals, and fiber necessary for a healthy body.

Portion to Portion

1. Answers will vary, but most students will estimate much larger amounts than actual portion sizes.
2. Some packages may include multiple portions, and the label can help you determine not only the portion size but also the nutritional values related to one portion of that food.

A Little "Pro" Testing

1. Answers will vary. Foods with protein should produce a smell similar to the burned feather.
2. Proteins build, maintain, and replace the tissues in your body.
3. Complete proteins contain all 9 of the essential amino acids and come from animal sources such as meat or milk. Incomplete proteins lack one or more of the essential amino acids and come from vegetable sources.

Getting to the Fat of the Matter

1. Answers will vary depending on the foods tested.
2. Foods containing fats will leave a mark on the paper.
3. Foods from the meat and bean group and the milk group may contain fats.
4. The yellow band on the new food pyramid represents fats. It is so narrow because the USDA is reminding us to limit the amount of fat included in our diet.

On the Web

Let's Plan Menus

1. The food guide pyramid provides the recommended daily servings for an average person, but each person has special dietary needs based on body size, health, and lifestyle.
2. Answers will vary.
3. A person who is more physically active on a regular basis will require more calories to maintain a healthy diet. A person must find a balance between the amounts of food eaten and physical activity by making smart food choices from each food group.

The NASA SCI Files™

The Case of the Physical Fitness Challenge

Segment 4

As the tree house detectives start to pull all the pieces together, they are beginning to realize that being physically fit involves more than they thought and that they need to make lifestyle changes. For some advice on how to be physically active for life, they visit Mr. Lynn Swann, former NFL football player and ABC Commentator, who also just happens to have been the Chairman for the President's Council on Physical Fitness and Sports. Mr. Swann helps the detectives learn that physical activity should be fun and something you enjoy doing so that you continue to be active. Meanwhile, the kids back in Scotland have been doing some more research of their own, and they head to the RRS *Discovery* to meet astronaut Alvin Drew to learn what NASA is doing to help keep astronauts healthy during long-duration space travel. Finally, the detectives are ready to put all the pieces together to help RJ get in shape, and they meet Dr. D for a wrap-up explanation that a healthy lifestyle includes many things, but especially proper nutrition and daily physical activity.

Objectives

Students will

- demonstrate the importance of stretching activities before and after exercise.
- simulate the effect of a reduced gravity environment on the human body.
- measure the effects of gravity on the spine.
- make a model of a spine.
- demonstrate the importance of flexibility to movement.
- understand the nutritional value of explorers' meals.
- design a nutritionally balanced diet for long-duration space flight.
- learn the benefits of an active lifestyle.

Vocabulary

aerobic endurance – ability to do moderately strenuous activity over a period of time; reflects how well your heart and lungs work together to supply oxygen to the body during exertion

flexibility – ability to move a joint through its full range of motion

healthy body composition – proper balance of fat in your body compared to your bone and muscle

muscle endurance – ability of muscles to hold a particular position for a sustained period or repeat a movement many times

muscle strength – ability of muscles to exert maximum force, such as lifting the heaviest weight you can, one time

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Prior to viewing Segment 4 of *The Case of the Physical Fitness Challenge*, discuss the previous segment to review the problem and what the tree house detectives have learned thus far. Download a copy of the **Problem Board** from the NASA SCI Files™ web site, select **Educators**, and click on the **Tools** section. The **Problem Board** can also be found in the **Problem-Solving Tools** section of the latest online investigation. Have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 3 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have occurred during Segment 3. Use tools located on the Web, as was previously mentioned in Segment 1.
4. Review the list of ideas and additional questions that were created after viewing Segment 3.
5. Read the overview for Segment 4 and have students add any questions to their lists that will help them better understand the problem.
6. **Focus Questions**—Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the program to answer the questions. An icon will appear when the answer is near.

View Segment 4 of the Video

For optimal educational benefit, view *The Case of the Physical Fitness Challenge*© in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. At the end of Segment 4, lead students in a discussion of the Focus Questions for Segment 4.
2. Have students discuss and reflect upon the process that the tree house detectives used to determine the importance of nutrition and physical fitness. The following instructional tools located in the **Educators** area of the web site may aid in the discussion: **Experimental Inquiry Process Flowchart** and/or **Scientific Method Flowchart**.
3. Choose activities from the **Educator Guide** and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.

4. For related activities from previous programs, download the appropriate **Educator Guide**. On the NASA SCI Files ™ home page, select the fence post that says "**Guides**." Click on the **2002–2003 Season** tab and then click on *The Case of the Biological Biosphere*©. In the green box, click on **Download the Educator Guide**.
   a. In the **Educator Guide** you will find
      a. Segment 3 – *Fitness for Life,* page 46
      b. Segment 4 – *Flexibility is the Key,* page 56

   Click on the **2004–2005 Season** tab and then click on *The Case of the Great Space Exploration*©. In the green box, click on **Download the Educator Guide**.
   b. In the **Educator Guide** you will find
      a. Segment 2 – *Puffy Head, Bird-Leg Syndrome*, page 34

   To locate additional activities and worksheets on the Web, click on **Activities/Worksheets** in the tool bar located at the top of the window. Scroll to the **2002–2003 Season** and click on *The Case of the Galactic Vacation*©. In the **Activities/Worksheet** section, you will find
      b. *Too Short*?
5. Wrap up the featured online PBL investigation. Evaluate the students' or teams' final product, generated to represent the online PBL investigation. Find sample evaluation tools in the Educators area of the web site under the main menu topic **Tools** by clicking on **Instructional Tools**.
6. Have students write in their journals what they have learned about health, nutrition, and physical fitness so that they can share their entry with a partner or the class.

Careers

fitness trainer
pharmacist
physician
professor
science educator
strength and conditioning specialist

Resources *(additional resources located on web site)*

Books

Crelinsten, Jeffrey: *To the Limit.* Harcourt College Publishers, 1992, ISBN: 0152006168.

Frost, Simon: *Flow Motion: Fitness for Young People*. Sterling Publishing Company, 2003, ISBN: 0806993731.

Gaines, Ann: *Female Stars of Physical Fitness*. Mitchell Lane Publishers, Inc., 2000, ISBN: 1584150238.

Jukes, Mavis: *Be Healthy! It's a Girl Thing: Food, Fitness, and Feeling Great*. Crown Books for Young Readers, 2003, ISBN: 0679890297.

Markle, Sandra: *Super Cool Science: South Pole Stations, Past, Present, and Future.* Walker and Company, 1998, ISBN: 0802784704.

Rabe, Tish: *Oh, the Things You Can Do That Are Good for You! All about Staying Healthy.* Random House, 2001, ISBN: 0375810986.

Wells, Rosemary: *Max and Ruby's Midas.* Penguin Group, 2003, ISBN: 0142500666.

Video

NASA Center for Distance Learning: *Destination Tomorrow*™*: Programs 16 and 17* (two-part series on food in space, looking at what astronauts will eat on future Mars missions)
Grades 9–adult

NASA Center for Distance Learning: *Destination Tomorrow*™*, Program18: Tech Watch – Challenges of Traveling to Other Worlds*
Grades 9–adult

NASA Center for Distance Learning: *NASA SCI-Files*™*: The Case of the Galactic Vacation*© (2002)
Grades 3–5

NASA Center for Distance Learning: *NASA SCI-Files*™*: The Case of the Great Space Exploration*© (2004)
Grades 3–5

Discovery School: *Body in Motion* (2004)
Grades K–5

Discovery School: *Eating for Your Future* (2005)
Grades 5–12

IMAX: *To the Limit* (1989)
Grades 3–adult

Web Sites

NASA KSNN™ (Kids' Science News Network™)
Find the answers to questions like, "Do astronauts need calcium in space?" or "How would your body change in space?" This site includes 60-second animations, activities, and resource links.
http://ksnn.larc.nasa.gov/exploration.html

Space Food
Visit this kid friendly NASA web site to learn about the kinds of foods astronauts eat in space and how they eat them.
http://www.nasa.gov/audience/forkids/home/F_Space_Food.html

Living in Space
On this NASA web site, learn about the foods astronauts eat, view video about space food, copy recipes to make actual space food, and learn what life in space is like.
http://spaceflight.nasa.gov/living/index.html

NASA Human Space Flight
Explore this NASA web site to learn more about the Space Shuttle and the International Space Station (ISS), go behind the scenes of human space flight, and get the latest space news.
http://spaceflight.nasa.gov/home/index.html

The President's Challenge – Physical Activity and Fitness Award Program
The President's Challenge is a program that encourages all Americans to make being active part of their everyday lives. The President's Challenge can help motivate people of any physical activity and fitness level.
http://www.presidentschallenge.org/

The President's Council on Physical Fitness and Sports
This web site is the health, physical activity, fitness, and sports information web site of the President's Council on Physical Fitness and Sports. Find out about the Council and its work, view its publications, and link to the resources of other government agencies as well as to health and fitness organizations.
http://www.fitness.gov/

Fit4Life
The United States Department of Health and Human Services Centers for Disease Control and Prevention's web site for kids has some quick tips for looking and feeling good—both inside and out. Check out Fit4Life for hints on eating healthy and getting active to keep your body and mind working for you!
http://www.bam.gov/fit4life/index.htm

Kidnetic.com
Find out why physical activity is important to your body and its systems.
http://www.kidnetic.com/home/bright_papers/bp_cat2_30.html

Science News for Kids
Discover why stretching is an important part of any physical activity and helps keep your body safe.
http://www.sciencenewsforkids.org/articles/20040505/Feature1.asp

Special Olympics
Learn more about the Special Olympics, which provides year-round sports training and athletic competition to more than 1.7 million people with disabilities in more than 150 countries.
http://www.specialolympics.org/Special+Olympics+Public+Website/default.htm

Space Grocery List
This site contains a list of astronauts' favorite foods you can find at a grocery store.
http://www.spacehab.com/space_grocery_list.pdf

Defying Gravity Online
Want to learn more about bones? This web site contains excellent lessons, hands-on experiments, and visuals to help you understand bone growth and the effects of calcium loss.
http://defyinggravity.net/bone.htm

HealthierUS.gov
Learn more about ways to stay healthy by being more physically fit, eating a nutritious diet, getting preventive health screenings, and avoiding risky behaviors. There are also links to other health-related web sites.
http://healthierus.gov/

Activities and Worksheets

Stretch It Out

Segment 4

Purpose

To demonstrate the importance of stretching activities before and after exercise

Materials

masking tape
cm measuring stick
science journal

Background

To move the body, muscles and tendons must be flexible—able to bend and stretch. Some people's muscles and tendons are more flexible than others. With practice, everyone can increase flexibility. Heavy physical activity can cause muscle soreness and tendon damage as the muscles contract. Daily stretching and stretching before and after exercise warms the muscles and connective tissue and increases the flow of oxygen and nutrients to the muscles. Stretching keeps muscles healthy, increases flexibility, and decreases the chances of muscle injury during physical activity.

Procedure

1. Put a strip of masking tape on the floor.
2. Sit on the floor with your legs straight out in front of you.
3. Make sure your back is lined up with the strip of tape on the floor.
4. Place your hands on your thighs, keeping your arms straight.
5. As you slowly exhale, bend at the waist, sliding your hands along your legs toward your feet.
6. Ask a partner to mark the place where your fingertips comfortably reach.
7. Measure the distance between this mark and the tape strip on the floor.
8. Record the length in your science journal.
9. Now do some simple stretches.

   a. Lie on the floor. Lift one leg and grasp the lower leg with both hands. Pull the leg gently toward your nose, keeping the leg straight. Stretch out to the side. Raise the other leg and repeat.

   b. Lie on your stomach. Raise your upper body off the floor, arching your spine. Then raise both feet. Try to touch your head with your toes.

   c. Kneel and sit on your heels. Bend down until your forehead touches the floor. Stretch your arms in front of you. Inhale, then exhale and stretch your arms out a little farther.

   d. Stand with both feet flat on the floor. Bend both knees as far as you can without lifting your heels from the floor. Repeat three or four times.

   e. Lie on the floor. Lift one leg and bend the knee so the lower leg is parallel to the floor. Point the toes forward. Put the toes back and stretch toward the shin. Switch legs.
10. Sit on the floor again, with your back lined up with the strip of tape.
11. Now try reaching towards your toes again.
12. Ask your partner to mark the place where your fingertips reach this time.
13. Measure the distance between this mark and the tape strip.
14. Record the distance in your science journal and calculate any difference in distance.
15. Repeat the activity each day for one week.
16. Record your findings and discuss them.

Stretch It Out

Segment 4

Discussion

1. How did the distance you could comfortably reach change after the stretching exercises?
2. What effect did stretching each day for one week have on your results?
3. Why is stretching before and after exercise important?

Extension

Try bending over and touching your toes. After you complete a few stretching activities, bend over and touch your toes again. Did you notice any difference?

Taking a Midnight Stretch

Segment 4

Purpose

To measure the effects of gravity on the spine

To simulate the effect of a reduced gravity environment on the human body

Materials

cm measuring tape
hardback book
pencil
height data sheet

Background

The force of gravity on Earth pulls down on the body all day, creating resistance that keeps bones and muscles strong. This force also compresses or pushes down on the cartilage discs in the back. These cartilage discs are like flexible sponges that act as shock absorbers as our bodies move. Just like sponges, the cartilage absorbs water, which can be squeezed out when a force pushes on it. During a night of rest, without gravity pressing them down, the cartilage discs expand, creating a temporary height increase.

Space travel has many effects on the human body. One effect is that an astronaut's height increases while he or she is in space. The increase in height happens because there is less gravity to compress the cartilage discs between the vertebrae in the spine. However, the astronauts do not continue to "grow" in space. Once the cartilage has expanded, it will not get any larger, but this phenomenon can cause an astronaut's height to increase by up to five centimeters. When the astronaut returns to Earth, his/her height also returns to normal. The effects on cartilage do not appear to cause any harm to astronauts, but space suits must be designed to compensate for this temporary change in height.

Procedure

1. Remove your shoes.
2. Stand straight with your back against the wall and your heels against the base of the wall.
3. Place a book, spine up, on top of your head. Make sure the edge of the book is against the wall above your head. See diagram 1.
4. Gently move your head back and forth until it feels like the bottom of the book is flat against the top of your head.
5. Hold the book tightly in position against the wall and carefully lower your head away from the wall.
6. Turn around and lightly mark with a pencil where the bottom edge of the book meets the wall.
7. Measure from this mark on the wall to the floor in centimeters.
8. Record the measurement as your "End of Day Height."
9. As soon as you get up in the morning, repeat steps 1–7.
10. Record the new measurement as your "Beginning of the Day Height."
11. Calculate the difference between the two marks. This difference is your "Overnight Height Change."
12. After walking around for 15 minutes, repeat steps 1–7.
13. Continue to walk for 30–45 minutes and repeat steps 1–7 again.
14. Record your findings.
15. Repeat the experiment each day for at least three days.
16. Be sure to keep notes about your sleep habits for each day, including the number of hours you slept each night and whether you got up during the night.
17. Compare your results with friends and family who are conducting the same experiment.

Diagram 1

Taking a Midnight Stretch

Segment 4

Discussion

1. What happened to your height each morning? Why?
2. How did this experiment simulate the effects of space on astronauts?
3. If an astronaut stays in space for an extended period of time, will he/she continue to grow?
4. What design changes would you make to ensure that a space suit fits an astronaut during flight?

Extension

1. Visit the web site: www.defyinggravity.net and click on the Bon-e Voyage link. In the visuals section, you will find a graph that shows data for how an astronauts' height changes while in space. Create a graph that shows what happened to your height each night. Compare your data to the astronauts' data and discuss any similarities or differences.
2. Watch an informative NASA video about the effects of space on the human body by visiting: *http://quest.nasa.gov/space/teachers/liftoff/system.html* Make a list of the effects of space flight on each of the body systems.

Height Data Sheet

	End of Day Height	**Beginning of Day Height**	**Overnight Height Change**	**Time Asleep**	**Notes About Sleep**
Day 1					
Day 2					
Day 3					

Record the time at which height returns to End of Day Height

Time Elapsed (minutes)	**15**	**30**	**45**
Height (cm)			

A Spindly Spine

Segment 4

Purpose

To make a spine model

Materials

small foam plate
foam cup
2 chenille sticks
24 wagon wheel macaroni noodles
hole-punch
scissors

Background

The body is made up of 206 bones that vary in shape and structure. Each bone is designed for a special purpose. The skull, for example, is made up of over 20 flat bones that are joined together and do not move at all. These bones provide the helmet-like protection needed for the brain. Other bones, such as the backbone or spine, are designed to make movement easier. The backbone is made up of thirty-three bones called vertebrae. These small ring-shaped bones protect the spinal cord and allow a wide range of motion that includes bending, lifting, pushing, and twisting.

Procedure

1. Punch two holes next to each other in the rim of a small foam plate.
2. Thread a chenille stick through the holes and twist the end so it is attached to the plate. The plate represents your skull, and the chenille stick represents the spinal cord. See diagram 1.
3. Thread seven wagon wheel macaroni noodles onto the chenille stick. They represent the seven cervical vertebrae or neck bones.
4. Fold another chenille stick in half and twist it around the spinal cord below the noodles to represent your shoulder bones or clavicles. See diagram 2.
5. Thread 12 more noodles on the spinal cord chenille stick. These 12 noodles represent the thoracic vertebrae, or upper backbones.
6. Add five more noodles onto the spinal cord chenille stick to represent the lumbar vertebrae, or lower backbones. See diagram 3 on page 89.
7. Using scissors, carefully cut the rim off a foam drinking cup. With the hole-punch, punch a hole in the back of the cup's rim and attach the bottom end of the spinal cord chenille stick to the rim through the hole. The rim of the cup will represent the pelvis, or hipbones. See diagram 4 page 89.
8. Holding your model carefully, try moving your model in different directions.
9. Observe its movement and record your observations in your science journal.

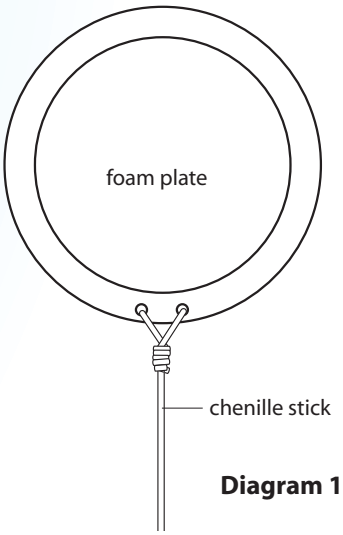


Diagram 1

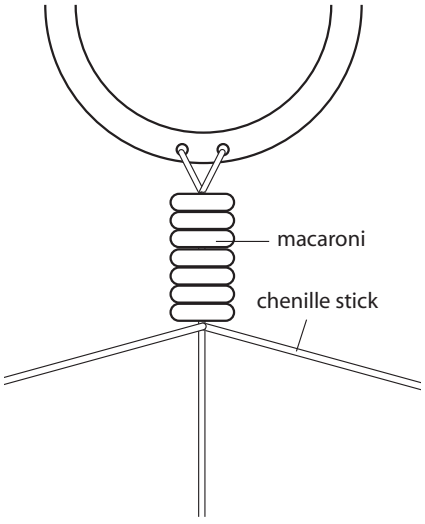


Diagram 2

A Spindly Spine

Discussion

1. How flexible is the model?
2. What would happen if the backbones were fused or stuck together?
3. Why is flexibility important to physical movement?

Extension

1. Put your hands on your back, just above the waist. Feel the muscles contract as you move from side to side or bend over. In your science journal, illustrate what you think your spine looks like and describe how it works with your muscles to move your body.

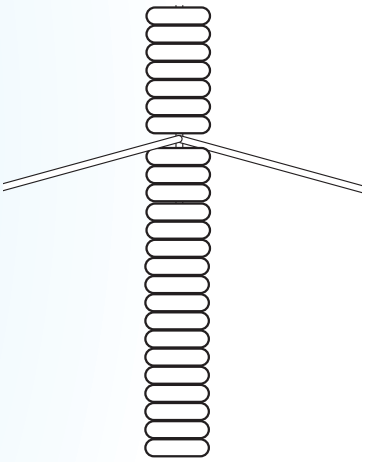


Diagram 3

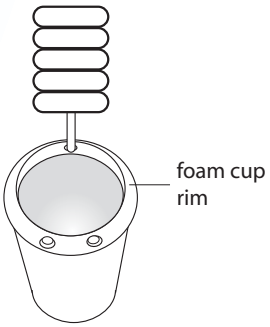


Diagram 4

Have Food Will Travel

Segment 4

Purpose

To understand the nutritional value of explorers' meals

To design a nutritionally balanced diet for long-duration space flight

Materials
computer with internet access
pencil

Background

When Captain Robert F. Scott and the crew of the RRS *Discovery* left England in 1901 to explore Antarctica, they took a variety of foods to meet their nutritional needs. When the explorers were stranded, the demands on them increased and they probably used more energy than they consumed. Although the average person uses about 2,000 calories each day, the explorers in Antarctica may have burned as many as 7,000–10,000 calories per day. By the end of their journey, they had basically no carbohydrates left to eat, existing on mainly seal, penguin, and seaweed. At this point, the explorers neither consumed enough calories to meet their level of activity nor had the variety of foods (especially carbohydrates and vitamins) in their diet necessary to fulfill basic nutritional needs. As a result, the explorers suffered from fatigue syndrome, a condition that made physical labor almost impossible.

Astronauts are also concerned about consuming a healthy diet, especially on long-duration space flights. Astronauts use about 3,500 calories per day, but the effects of space on their bodies sometimes make it difficult for astronauts to get the proper nutrition. For example, fluids in the body shift, leaving crewmembers congested, so food doesn't have much taste. To compensate for reduced taste sensations, astronauts often season their food with hot sauce or ketchup. Astronauts also report just not feeling hungry or being too busy to think about eating.

To be sure the astronauts are getting enough food and the correct amounts of each food type to meet their nutritional needs, nutritionists work with the astronauts and carefully plan their menus for space. To help monitor general food intake, astronauts keep a food frequency journal that records how many items they eat each day. Even beverages and water intake are recorded. As missions to the Moon, Mars, and beyond proceed, space nutrition will change even more. For example, astronauts may need to grow some of their foods. Technology and science will continue to help the astronauts live healthy lives even while they're away from Earth.

Procedure

1. Visit www.mypyramid.gov and click on "My Pyramid Plan."
2. Put in your age, gender, and the amount of physical activity you do each day.
3. Click "submit" and find your average needs for each food group.
4. On the right side of the page, click on the "Meal Tracking Worksheet."
5. Download and print a copy.
6. Use this sheet to keep track of everything you eat in a day.
7. Compare your food intake to the recommended amounts of each food group.
8. In your science journal, write an evaluation of your food choices.
9. Do some research to find out about which foods travel well in space.
10. Plan a 10-day rotating menu for a long-duration space flight. (Remember that astronauts need about 3,500 calories per day and that they will eat these same meals 18 times on a 180-day mission.)

Have Food Will Travel

Activity Sheet

Discussion

1. Why is a nutritionally balanced diet important?
2. What special problems do astronauts face when planning a diet?
3. Why do people have different nutritional needs?

Extension

1. To learn more about the RRS *Discovery* and Captain Robert F. Scott, visit the RRS *Discovery* Museum web site *http://www.rrsdiscovery.com/*
2. Visit the NOVA web site to learn more about the Shackleton expedition to Antarctica: *http://www.pbs.org/wgbh/nova/shackletonexped/1914/*
3. Complete the online adventure to learn more about endurance diets. *http://www.pbs.org/wgbh/nova/shackletonexped/classroom/w4meal.html.* Calculate the number of calories consumed by the Antarctic explorers and evaluate their diets' nutritional quality.
4. Conduct research to learn more about other historic expeditions.
5. When man explored the Moon for the first time in July 1969, we knew more about the Moon than Captain Scott knew about Antarctica when he began his expedition. Research and explain why.

Finding Physical Fitness

Segment 4

Understanding the words in this puzzle will be your first step to better physical fitness, so get hopping and find these words!

aerobic
exercise
joint
muscles
stress
bone marrow
calories
carbohydrates
ligaments
macronutrients
metabolism
musculoskeletal system
nutrients
Basal Metabolic Rate
proteins
osteoporosis
flexibility
endurance
strength
resistive exercise

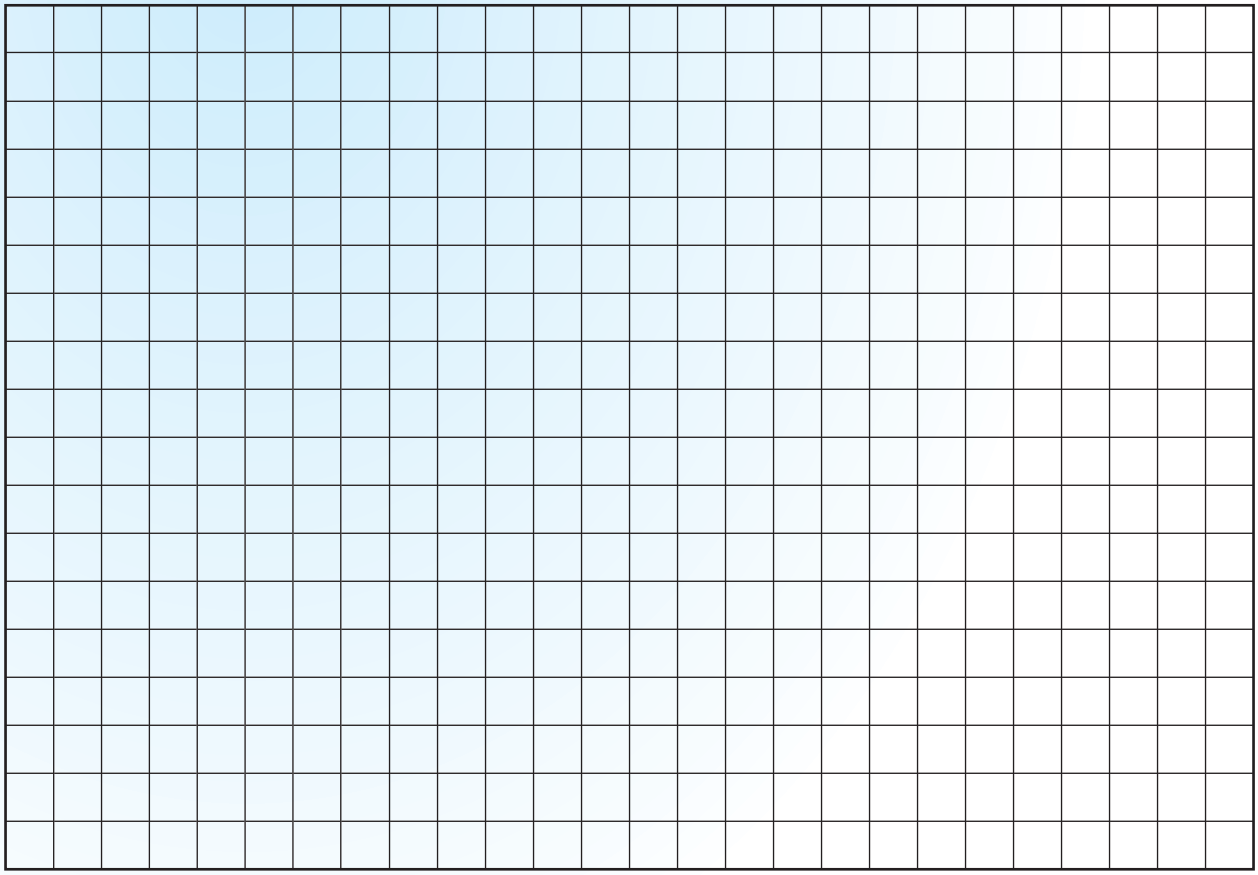
M C E A N C A M P R Y Y T I L I B I X E L F
U E M O M G A S S E D I T E J O I N T I I I
S M T A M O R P M E T S Y A H E R A E L B G
C O A A E P E R I A K M C I C R I P A O A N
U N M C B I O M B N G K M S T M N T R T S E
L H E E R O S T E O P O R O S I S T E H A O
O I A I N O L K S E I R O L A C E E S Y L U
S J G L Z D N I M D C C L T U O S R I D M F
K L P A E T U U S C T O F L P I S M S R E I
E A I E E E W R T M Z N S O M N E O T S T L
L S M W R T I A A R T V R U E E R H I T A A
E X E R C I S E V N I O R M R I T A V R B M
T N L D S A I N D E C E E M S A S L E E O E
A G E A R S Z A I E S E N O I E P I E N L N
L I G A M E N T S G P T W T B R A N X G I T
S S P A C E S T T T I O O T S O C E E T C H
Y E N S I T Y C N R R E R T E B E I R H R S
S E N E I G P S E E E S R O E I A C C E A N
T E R T C E F F I S I L A I R C C T I C T I
E K A T I I T G R D T B M R B I L L S A E E
M U S C L E S I T D R I E I O Y T I E F R T
G A E M O H S O U I T E N A T I V E N R U O
P E R M E A B L N C S N O K K I N Y N U P R
M F A S E T A R D Y H O B R A C O T S S R P

Stretch and Tone Crossword Puzzle

Segment

Use the words below to create your own crossword puzzle

cardiac muscles
stress
bone marrow
calories
carbohydrates
ligament
macronutrients
exercise
metabolism
nutrients
proteins
flexibility
muscles
endurance



Across

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Down

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Answer Key

Segment 4

Stretch It Out

1. Answers will vary, but students should see an increase in the distance they were able to reach after stretching.
2. Students should be able to reach slightly farther at the start of each trial after stretching for a week.
3. Stretching before and after exercise helps the body warm up and cool down, increases flexibility, keeps muscles healthy, and decreases the chance of muscle injury.

Taking a Midnight Stretch

1. Your height increases slightly each morning. During the night, the cartilage discs between the vertebrae in the spine expand, creating a temporary height increase.
2. Because there is little gravity in space, the cartilage discs in an astronaut's spine expand, holding water in them, and thus giving the astronaut added height while he or she is in space.
3. No, the astronaut will not continue to grow. Once the cartilage has expanded, it will not get any larger. Astronauts will also return to their normal height when they return to Earth's gravity.
4. Answers will vary, but students should understand that the astronaut suit must be a closed system, and yet it must be flexible enough to accommodate the change in height.

Have Food Will Travel

1. A nutritionally balanced diet helps ensure that you get enough vitamins, minerals, and calories to meet your activity level.
2. Astronauts are often congested in space, so food doesn't taste good. They also report not feeling hungry and/or being too busy to eat. In addition, astronauts on long-duration flights must eat the same kinds of food several times during the trip.
3. People have different nutritional needs based on their age, size, gender, overall health, and level of physical activity.

A Spindly Spine

1. The model is very flexible, allowing movement in several different directions.
2. If the backbones were fused together, bending would not be possible and other movements would be severely limited.
3. Flexibility is one component of physical fitness. We need flexibility in daily life to do tasks as simple as fastening a button or as complex as playing soccer. Flexibility can increase our range of motion, relieve muscle soreness, and reduce injury risk.

Finding Physical Fitness

On the Web

The President's Challenge

Physical Activity and Fitness Awards Program

1. The Active Lifestyle and Presidential Champions programs are for individuals who want to earn awards while becoming healthier.
2. Staying active helps improve heart health, builds strong bones, creates a sense of well being, develops a social life, and improves physical appearance.
3. The web site encourages you to

   a. enter your activities on the activity log

   b. review your progress

   c. earn awards
4. Answers will vary.
5. Answers will vary, but may include any of the activities listed on the Challenge list: take your dog out for a walk; play tag with kids in your neighborhood; help your parents do yard work; see how many jumping jacks you can do, and so on.